



# AERONAUTICAL ENGINEERING

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A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 90

DECEMBER 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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**Accession numbers cited in this Supplement fall within the following ranges:**

**STAR (N-10000 Series)      N77-30065—N77-34092**

**IAA (A-10000 Series)      A77-44314—A77-51633**

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# AERONAUTICAL ENGINEERING

## A Special Bibliography

### Supplement 90

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in November 1977 in

- *Scientific and Technical Aerospace Reports (STAR)*
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# INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued

This supplement to *Aeronautical Engineering -- A Special Bibliography* (NASA SP-7037) lists 351 reports, journal articles, and other documents originally announced in November 1977 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

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## TYPICAL CITATION AND ABSTRACT FROM STAR

NASA SPONSORED DOCUMENT		AVAILABLE ON MICROFICHE
NASA ACCESSION NUMBER	N77-10048*#	
TITLE	CIVIL USES OF REMOTELY PILOTED AIRCRAFT Summary Report	CORPORATE SOURCE
AUTHORS	Jon R Aderhold, G Gordon, and George W Scott Jul 1976 28 p ref	PUBLICATION DATE
CONTRACT OR GRANT	(Contract NAS2-8935)	
REPORT NUMBERS	(NASA-CR-137895, LMSC-D057322) Avail NTIS HC A03/MF A01 CSCL 01C	AVAILABILITY SOURCE
	The economic, technical and environmental implications of remotely piloted vehicles (RVP) are examined The time frame is 1980-85 Representative uses are selected, detailed functional and performance requirements are derived for RVP systems, and conceptual system designs are devised Total system cost comparisons are made with non-RPV alternatives The potential market demand for RVP systems is estimated Environmental and safety requirements are examined, and legal and regulatory concerns are identified A potential demand for 2,000-11,000 RVP systems is estimated Typical cost savings of 25 to 35% compared to non-RPV alternatives are determined There appear to be no environmental problems, and the safety issue appears manageable	COSATI CODE
	Author	

## TYPICAL CITATION AND ABSTRACT FROM IAA

NASA SPONSORED		AVAILABLE ON MICROFICHE
AIAA ACCESSION NUMBER	A77-10214*#	
TITLE	Resizing procedure for structures under combined mechanical and thermal loading. H M Adelman (NASA, Langley Research Center, Hampton, Va) and R Narayanaswami (Old Dominion University, Norfolk, Va.). AIAA Journal, vol 14, Oct 1976, p 1484-1486 6 refs	AUTHORS
PUBLICATION DATE		AUTHOR'S AFFILIATION
	The fully-stressed design (FSD) appears to be the most widely used approach for sizing of flight structures under strength and minimum-gage constraints Almost all of the experience with FSD has been with structures primarily under mechanical loading as opposed to thermal loading. In this method the structural sizes are iterated with the step size, depending on the ratio of the total stress to the allowable stress In this paper, the thermal fully-stressed design (TFSD) procedure developed for problems involving substantial thermal stress is extended to biaxial stress members using a Von Mises failure criterion The TFSD resizing procedure for uniaxial stress is restated and the new procedure for biaxial stress members is developed Results are presented for an application of the two procedures to size a simplified wing structure	S D

# AERONAUTICAL ENGINEERING

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## IAA ENTRIES

**A77-44316 #** Analysis/theory of controlled configured structures S D Gratke and J G Williams (Vought Corp, Dallas, Tex) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1212* 8 p

Modern swept wing aircraft wing substructure has traditionally been configured with the shear carrying spars oriented along lines of constant chord percentage, i.e., 30% chord, 50% chord, etc. This arrangement may produce leading edge up wing twist during flexural loading resulting in undesirable wing and aircraft performance. The leading edge up rotation increases the angle of attack of the outboard portion of the wing causing the tip to stall at a lower airplane angle of attack than the remainder of the wing. This stalled tip at high g levels no longer produces lift and increases drag, therefore, reducing the aircraft performance. To alleviate this problem of stalled tips, built in leading edge down twist has been built into the wing. This is very costly from a manufacturing standpoint, and has a detrimental effect on the aircraft during negative g maneuvers by having a built in angle of attack increase (Author)

**A77-44317 #** Analysis methods and computer programs developed for the YC-15 STOL flight test program H K Cheney (Douglas Aircraft Co., Long Beach, Calif) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1215* 7 p 6 refs

New analysis methods and advanced instrumentation were used to evaluate the flight test performance of the YC-15 STOL transport. The computations required to analyze various performance items were combined into computer programs. These programs organize the measured data into convenient formats, calculate basic performance parameters, standardize test results to final values, and provide a summary of the performance obtained during a test run. Programs were developed for powered-lift equilibrium flight path angle, takeoff distance, and landing distance performance. Equilibrium flight-path performance potential was computed for climb, descents, level flight acceleration, and approaches to stall. A modified Inertial Navigation System (INS) was used to improve the accuracy of rate-of-change of energy during flight maneuvers and as a backup to Laser Tracking System data for takeoff and landing performance. The development of the computer programs, interesting analysis features, and the quality of results obtained from the YC-15 Flight Test Program are described in this paper (Author)

**A77-44318 #** A digital data acquisition and reduction system for flight testing general aviation aircraft. R J Freuler and M J Hoffmann (Ohio State University, Columbus, Ohio) *American*

*Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1216* 9 p

A digital data acquisition and reduction system has been implemented for flight testing of light general aviation aircraft. The package has been assembled from off-the-shelf components and is intended for use in aircraft, where minimum weight and low power requirements are of primary concern. The design objectives for the package were to provide an accurate, timely, and relatively low cost data acquisition and reduction system for flight test aircraft environments while maintaining flexibility in application, reliability in performance, and a capability for in-flight data reduction. Discussion of the design constraints and objectives which were met and those which had to be compromised is presented. A complete system description at both the hardware and software levels is included (Author)

**A77-44319 \* #** Flight test results for an advanced technology light airplane D L Kohlman *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1217* 9 p 11 refs Grant No NGR-17-002-072

A single engine light airplane was modified by the installation of a wing with reduced area, Fowler flaps, Kruger flaps, and spoilers. Flight test results show that zero-lift drag was reduced 13.8% and a trimmed maximum lift coefficient of 2.73 was achieved. Gust response was significantly reduced and excellent roll control was achieved with spoilers. Several design features employed in the new wings have excellent potential for incorporation in future light airplanes (Author)

**A77-44320 #** An integrated approach to the problem of aircraft icing D W Newton (Cessna Aircraft Co., Aircraft Radio and Control Div., Boonton, N.J.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1218* 10 p 9 refs

The paper is addressed to the need for a definition of the intensity of icing conditions in terms of meteorological parameters which the forecaster can predict, the manufacturer can design to, and the pilot can identify. Contradictions in present regulatory and meteorological definitions of icing conditions are discussed, and a method of resolving them is suggested. A discussion of the FAR 25 icing envelopes as engineering rather than meteorological standards is presented. The question of whether a mean effective drop diameter is representative of the drop size spectrum within an icing cloud is considered. Definitions of icing intensity are suggested, and a method of flight test data acquisition allowing determination of the intensity of icing conditions encountered is described (Author)

**A77-44321 #** Characteristics of fighter aircraft. G O Madelung (Panavia Aircraft GmbH, Munich, West Germany). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1219* 7 p

The history of fighter aircraft is reviewed, taking into account early developments, the introduction of the jet aircraft, and the

fighters which were developed in the mid-50's. The current situation with respect to the requirements for new fighter designs is investigated. Attention is given to V/STOL concepts in connection with airfield vulnerability considerations, low level/high speed penetration, fan-jet engines, terrain following radar systems, the variable sweep wing, the improvement of air-to-air combat capability in connection with design changes involving a decrease in wing loading, the 'look-down' capability of radar, the significance of avionics, refinements in aircraft propulsion systems, aspects of post-stall maneuverability, the desirability to overcome the limitations of the fixed gun, and the development of unmanned fighter aircraft. G R

**A77-44322 # Parametric study of advanced long range military/commercial cargo transports.** R H Lange and E S Bradley (Lockheed-Georgia Co., Marietta, Ga.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1221.* 8 p. 19 refs.

This paper describes the results of Lockheed parametric design studies of the performance and economics of advanced technology military/commercial cargo transports envisioned for operation in the 1985 and 1995 time period. The design parameters investigated include payloads from 220,000 to 550,000 pounds and ranges from 3,500 to 5,500 nautical miles. All configurations have supercritical wings, advanced composite materials, relaxed static stability, and low noise levels. The application of laminar flow control (LFC) technology on the performance of an advanced military transport is also presented. (Author)

**A77-44323 \* # Mass flow requirements for LFC wing design.** A J Srokowski (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.) and S A Orszag (MIT, Cambridge, Mass.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1222.* 16 p. 31 refs.

The problem of determining optimum suction mass flow requirements for LFC wings is addressed. Some previous methods for predicting the extent of laminar flow over swept wings with suction are briefly reviewed. These range from the purely empirical to those utilizing tabulated linear stability computations. The present method is described. This method solves the linear, incompressible stability equations by spectral techniques. The maximum temporal amplification of boundary layer crossflow and 2D disturbances is determined for waves of a given frequency. Group velocities are used to integrate these amplification rates along the wing to yield the logarithmic amplitude ratio or 'N factor' of the disturbance. The 'N factor' calibration of a computer code utilizing this method is described, using experimentally determined transition data. The method is shown to be as consistent as previously used 'fixed wavelength' methods. (Author)

**A77-44324 \* # Advanced turboprop technology development** J F Dugan (NASA, Lewis Research Center, Cleveland, Ohio), D P Bencze, and L J Williams (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1223.* 16 p. 17 refs.

In order for new short-medium range transports to offer significantly lower operating costs than potential derivatives of current designs using advanced technology, the efficiency improvements of high-speed turboprop propulsion systems may be required. Recent studies indicate that the fuel savings of advanced turboprop aircraft appears to be 10 to 20 percent relative to equivalent technology turbofan aircraft. These fuel savings are certainly large enough to warrant further research to establish the viability of turboprop transport aircraft. The studies have identified the technology requirements in propeller design for high efficiency and low noise, fuselage noise attenuation, propeller and gear box maintenance, and engine-airframe integration. This paper presents a review of present research in each of these areas and describes the future

plans for continued development of the technology for advanced turboprop transport aircraft. (Author)

**A77-44325 \* # Nonaxisymmetric nozzle technology program - An overview** B L Berrier (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.), J L Palcza (U S Naval Air Propulsion Test Center, Trenton, N.J.), and G K Richey (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1225.* 12 p. 21 refs.

Nonaxisymmetric nozzles, with in-flight thrust vectoring and/or reversing capabilities, provide the potential for substantial gains in fighter aircraft performance, maneuvering, survivability and ground handling. This paper presents an overview of some of the current programs to develop nonaxisymmetric nozzle technology for future aircraft applications. The initial phase of this program, which consists of a series of subscale model tests, engine/nozzle studies, system integration studies and simulation studies, has been initiated. Successful completion of this program will allow designers of future aircraft to consider, with high confidence, the integration of nonaxisymmetric nozzle concepts to improve aircraft mission performance effectiveness, survivability and cost. (Author)

**A77-44326 \* # Effect of an integrated scramjet installation on the subsonic performance of an aircraft designed to Mach 6 cruise** P J Johnston, J L Pittman (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.), and J K Huffman (NASA, Langley Research Center, Subsonic-Transonic Aerodynamics Div., Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1230.* 11 p. 8 refs.

Various factors contributing to the high drag caused by the installation of a six-module scramjet engine were determined from wind tunnel tests at Mach numbers from 0.2 to 0.7. Methods for alleviating this drag were also explored. The external exhaust nozzle, required for good cruise performance, was a major contributor. Of the drag produced by the engine modules, a significant fraction was attributable to wall divergence in the combustor. Good drag simulation could be achieved by using a single fuel injection strut having approximately the same cross-sectional area as the three used on the full-scale engine. External exhaust nozzle fences had a small but beneficial effect on maximum L/D and a flap which diverted the flow away from the inlet was effective in decreasing drag but only at low angles of attack. (Author)

**A77-44327 # Powered lift - Its impact on YC-14 materials and structures** P J Harradine (Boeing Aerospace Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1231.* 8 p.

As a result of the selection of the upper surface powered lift system for the YC-14, thermal and acoustic environments became a major factor in the design of wing and aft fuselage structures. The thermal environment governed the selection of flap materials and necessitated use of a heat shield to protect the aluminum alloy wing box upper surface. The flap and aft fuselage structural concepts were strongly influenced by the acoustic environment in takeoff and approach conditions. Cost and weight effective design solutions were developed within state of the art practices, reinforced by analysis and testing. The designs have been verified by full scale ground and flight tests. (Author)

**A77-44328 # Cast aluminum structures technology** D D Goehler (Boeing Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1232.* 8 p. USAF-supported research.

The CAST project has the objective to establish necessary structural and manufacturing technologies and to demonstrate the integrity, producibility, and reliability of cast aluminum primary



airframe structures. The program goal is to demonstrate a minimum of 30% acquisition cost savings with no weight penalty. Current projections show that by applying CAST technology to the possible C-14 production program, savings of over \$100 million could be obtained. G R

**A77-44329 #** Advanced composites and advanced metallics meet the challenge of design-to-cost. L. Ascani and L. Lackman (Rockwell International Corp., Los Angeles Aircraft Div., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1234* 10 p

Aircraft technology is continually developing innovative concepts to produce aircraft with higher performance and lower cost. This is particularly true in the field of aircraft structures, since the structural airframe is a large fraction of the total cost and weight of an aircraft. Advanced structural concepts, which include integral structure of advanced composites and superplastically-formed/diffusion bonded (SPF/DB) titanium, promise to produce significant reductions in airframe costs and weights. Design studies using both types of structure on a new-generation aircraft are compared to conventional materials and methods of construction. (Author)

**A77-44330 \* #** Application of powered lift and mechanical flap concepts for civil short-haul transport aircraft design. J. A. Conlon and J. V. Bowles (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1237* 9 p 10 refs

The objective of this paper is to determine various design and performance parameters, including wing loading and thrust loading requirements, for powered-lift and mechanical flap conceptual aircraft constrained by field length and community noise impact. Mission block fuel and direct operating costs (DOC) were found for optimum designs. As a baseline, the design and performance parameters were determined for the aircraft using engines without noise suppression. The constraint of the 90 EPNL noise contour being less than 2.6 sq km (1.0 sq mi) in area was then imposed. The results indicate that for both aircraft concepts the design gross weight, DOC, and required mission block fuel decreased with field length. At field lengths less than 1100 m (3600 ft) the powered lift aircraft had lower DOC and block fuel than the mechanical flap aircraft but produced higher unsuppressed noise levels. The noise goal could easily be achieved with nacelle wall treatment only and thus resulted in little or no performance or weight penalty for all studied aircraft. (Author)

**A77-44331 #** Thrust augmenting ejector technology for Navy aircraft. K. A. Green and J. D. Cyrus (US Naval Material Command, Naval Air Development Center, Warminster, Pa.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1239* 12 p 18 refs

The employment of V/STOL aircraft in the Navy is considered in connection with a number of operational advantages which could be obtained by using such aircraft. One of the propulsion concepts explored involves the employment of wing or fuselage mounted thrust augmenting ejectors. Ejector technology has, in large measure, evolved from the XFV-12 A program. However, much remains to be done in this area. The design of a long-range technology development plan is discussed. Attention is given to corner flows and wall jets, the design of compact diffusers, primary nozzles, a jet-diffuser ejector, reaction control augmenters, scaling effects, and prediction methods. G R

**A77-44332 #** Design criteria for aircraft warning, caution and advisory alerting systems. J. E. Veitengruber (Boeing Commercial Airplane Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1240* 9 p. FAA-supported research

An overabundance of warning, caution and advisory alerts will exist in the cockpits of future commercial transport aircraft if current cockpit design trends are not altered. Coupled with this proliferation of alerts is a lack of correlation between alert type applications and significance. The potential for pilot saturation and/or confusion exists with these alerts. A study was performed for the FAA to identify these problem areas and to develop design guidelines for alerting systems in new aircraft. Recommendations resulting therefrom include (1) improve pilots' audio/visual environment by minimizing exposure to unnecessary alerts, (2) incorporate central alphanumeric alert readout devices, and (3) improve categorization and/or prioritization of alerts. (Author)

**A77-44333 #** Head-up display in commercial aviation. R. J. Phaneuf and J. E. O'Brien (Air Line Pilots Association, Washington, D.C.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1241* 10 p 40 refs

The potential role of head up display in US commercial aviation as viewed by the airline pilot is summarized. A brief review of the development of such systems is presented with emphasis on the problems encountered and the time intervals involved. Following a presentation of a candidate head-up display system, the paper analyzes the remaining problems which must be resolved before such a system is likely to see widespread usage in the US airline industry. (Author)

**A77-44334 #** The effect of terrain near airports on significant low level wind shear. D. F. Sowa (Northwest Orient Airlines, St Paul, Minn.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1242* 5 p

Unique terrain near an airport can cause significant low level wind shear to exist under certain meteorological conditions. The presence of severe turbulence can compound the shear problem. The terrain near two airports, Anchorage, Alaska and Portland, Oregon, is discussed along with specific weather patterns that produce wind shear at each airport. Specific procedures are given that enable a pilot to identify the shear by type. Operational techniques that effectively reduce the effect of the shear and the intensity of the turbulence at Anchorage are given. (Author)

**A77-44335 #** Case studies in aircraft design. U. Haupt (US Naval Postgraduate School, Monterey, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1244* 10 p 11 refs

A survey is given of various trends in aircraft design and in design education. A discussion of these trends indicates that a new generation of designers will have to be highly capable in a broad field from sophisticated methods to practical engineering experience. Neither engineering science curricula nor engineering technology curricula can be expected to prepare designers for this broad field. A proposal for a fresh approach is submitted where continuing education provides design-oriented courses for those engineers who choose a career in design. It will be necessary to prepare design-oriented text material and course outlines for design-oriented courses. The preparation of design-oriented text material as well as other aspects are discussed in some detail. (Author)

**A77-44336 \* #** Wing design by numerical optimization. R. M. Hicks (NASA, Ames Research Center, Moffett Field, Calif.) and P. A. Henne (Douglas Aircraft Co., Long Beach, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1247* 8 p 11 refs

A study was conducted to assess the feasibility of performing computerized wing design by numerical optimization. The design program combined a full potential, inviscid aerodynamics code with a conjugate gradient optimization algorithm. Three design problems were selected to demonstrate the design technique. The first involved

modifying the upper surface of the inboard 50% of a swept wing to reduce the shock drag subject to a constraint on wing volume. The second involved modifying the entire upper surface of the same swept wing (except the tip section) to increase the lift-drag ratio subject to constraints on wing volume and lift coefficient. The final problem involved modifying the inboard 50% of a low-speed wing to achieve good stall progression. Results from the three cases indicate that the technique is sufficiently accurate to permit substantial improvement in the design objectives (Author)

**A77-44337 \* # Optimum acoustic design of free-running low speed propellers** A I Ormsbee and C J Woan (Illinois, University, Urbana, Ill.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1248* 6 p 8 refs Grant No NGR-14-005-194

A theoretical analysis is conducted concerning the effect of blade loading on the noise output of a free-running propeller in axial motion. The minimization of the mean square sound pressure at a point in space is considered, taking into account constraints on propeller thrust and torque. Attention is given to aerodynamic equations, acoustic equations, the expansion of the aerodynamic variables, and the nonlinear programming formulation G R

**A77-44339 # The profile descent** F L Cunningham (FAA, Washington, D C.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1251* 5 p

This new air traffic control procedure is being implemented at all airports that accommodate high performance, turbine powered aircraft. Profile descent is designed to permit the operator to descend in a clean configuration at idle thrust to the final approach course. Delays caused by demand exceeding airport acceptance will be absorbed at higher altitudes and not in the terminal area. In addition to a significant arrival burn savings, safety, noise abatement, and standardization of arrival procedures will be enhanced (Author)

**A77-44340 # Role of future automated flight deck displays in improving operating costs** J W Lukins (Boeing Commercial Airplane Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1252* 10 p

This independent paper discusses the role of future automated flight deck displays and systems which will improve the operating economics of commercial jet airplanes. As an introduction to the present trends of rising operating costs, an overview of the situation that the airlines are facing is given. This is followed by some general comments on new design technology for aerodynamic, structural and engine optimization which will help operating costs on the next generation aircraft. A detailed discussion is then provided on cockpit systems that have recently become available or are expected in the near future. Special attention is given to devices which compute and display information to the flight crews which allows them to fly cost optimal flight profiles (Author)

**A77-44343 # Air New Zealand's methods of flying the DC-10** W H Dunn (Air New Zealand, Ltd., Auckland, New Zealand) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1255* 8 p

The described methods are concerned with an achievement of maximum payloads and minimum fuel costs. An average reduction in takeoff power to a value which is about 15 percent below the maximum power available has been obtained with the aid of a derating technique which ensures good aircraft performance safety. A circular slide rule is used for all phases of flight from takeoff to landing for determining engine power setting and checking engine performance and aircraft drag. Attention is given to the takeoff thrust setting, the effect of runway conditions on performance, performance margins, a method of presentation of takeoff data for

individual runways, an en route climb technique, and aspects of cruise performance presentation G R

**A77-44344 # Applicability of axisymmetric analysis in predicting supersonic flow through annular cascades** H-H Fruehauf (Stuttgart, Universität, Stuttgart, West Germany) (*American Society of Mechanical Engineers, Paper 76-Pwr-B*, 1976) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol 99, Jan 1977, p 115-120 5 refs Research sponsored by the Deutsche Forschungsgemeinschaft

Solutions of the differential equations of the axisymmetric model and circumferentially averaged solutions of the differential equations of the three-dimensional model are compared quantitatively for steady supersonic flows through rotating annular cascades. Thereby three-dimensional corrections for flow quantities, which determine the applicability of the axisymmetric analysis, are investigated as a function of geometrical and gas dynamical parameters. Finally, these three-dimensional corrections are compared to three dimensional corrections for the solutions of the usual blade-to-blade model on cylindrical surfaces of revolution for identical annular cascades (Author)

**A77-44345 # Stall margin improvement by casing treatment - Its mechanism and effectiveness** H Takata (Tokyo, University, Tokyo, Japan) and Y Tsukuda (Mitsubishi Heavy Industries, Ltd., Takasago, Hyogo, Japan) (*American Society of Mechanical Engineers, Paper 76-GT-A*, 1976) *ASME, Transactions, Series A - Journal of Engineering for Power*, vol 99, Jan 1977, p 121-133 5 refs

Experiments on the effect of casing treatment were carried out using low-speed axial-flow compressors. Results on the overall compressor performance and on the flow through the blade row as well as the flow within the treatment slots are presented. Then, based on the experiments, a possible mechanism of the stall margin improvement is suggested (Author)

**A77-44427 \* # An overview of Viking navigation.** W J O'Neil (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.) In *National Aerospace Meeting, Denver, Colo., April 13, 14, 1977, Proceedings* Washington, D C., Institute of Navigation, 1977, p 1-8 Contract No NAST 100

Viking flight path design and inflight control of Viking 1's path from earth launch to Mars landing are described. Attention is directed to the Lander descent, accessible area constraints, orbit insertion design, and earth departure control. Other topics include the orbital operations plan, the Viking heliocentric trajectory, and Mars approach control M L

**A77-44431 # United's experience with computer generated visual systems, April 1977** G V McCulloch (United Air Lines Flight Training Center, Denver, Colo.) In *National Aerospace Meeting, Denver, Colo., April 13, 14, 1977, Proceedings* Washington, D C., Institute of Navigation, 1977, p 28-30

Experience with three types of simulator visual systems in operational use is reported. The three types are computer generated imaging (CGI), cinematography, and closed circuit television with model board. CGI is considered preferable on the basis of economy and operational viability. Some apparent (i.e., not yet experimentally verified) advantageous features include the gaming area, transport lag and synchronization, visual field, topographic verisimilitude, and visual attributes. The most serious disadvantages are thought to involve the light point quality, weather simulation, and scene perspective. For example, while the real light points that define the night signature of an airport and city have almost infinite variability, the light points in the CGI display have a very limited variety. Research aimed at establishing transfer-of-learning effectiveness for the features of CGI systems is urged M L

**A77-44432 # RNAV waypoint charting effects on pilot procedures, training and workload.** R J Adams (Systems Control,

Inc, West Palm Beach, Fla ) and P Rich (FAA, Washington, D C ) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 31-37 7 refs

With consideration of the 1973 report, 'Application of Area Navigation in the National Airspace System', a summary is presented of the analytical procedure used to establish waypoint charting requirements From this theoretical base, the paper introduces several currently used area navigation (RNAV) Standard Instrument Departure (SID) and Standard Terminal Arrival Routes (STAR) The advantages gained by both the pilot and air traffic control system through the proper use of pilot procedures is quantified by using detailed flight test results from the Miami, Denver, and Chicago terminal areas and also flight simulator results M L

**A77-44433 # Terminal area charting for area navigation operations** E D McConkey (Systems Control, Inc, West Palm Beach, Fla ) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 38-42

**A77-44434 # Fuel conservation for high performance aircraft in the terminal area** S C Mohleji (Mitre Corp , Metrek Div , McLean, Va ) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 43-46-C 7 refs

In a high density terminal area, speed control and radar vectoring are typically used to optimize the sequence and assure the spacing of landing aircraft for maximum runway utilization The paper describes an approach for the Air Traffic Control (ATC) system in the terminal area to accommodate fuel conserving landing approaches Analytical results are presented that illustrate the impact of fuel economic design on terminal controllability and airport capacity Peak hour trade-offs between conserving fuel and maximizing runway utilization are also included in the paper An analytical fuel consumption model is used to estimate the fuel benefits of lifting the 250 knots speed restriction below 10,000 ft mean sea level (MSL), for both arrivals and departures (Author)

**A77-44435 # Probing the airborne Omega environment** J J Scavullo (FAA, National Aviation Facilities Experimental Center, Atlantic City, N J ) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 53-58 6 refs

Prospective users have begun to request the Federal Aviation Administration (FAA) to certify the Omega Navigation System over oceanic jet routes and over the routes of off-shore oil-lease areas The FAA has sampled the quality and coverage of Omega signals in many of these areas Data recorded during a number of probe flights has been consistent with forecasts of coverage as well as with predicted gaps due to large discontinuities along the propagation pathway, such as the dielectric ice mass on Greenland The paper proposes to extend in-flight data collection all around the world during the imminent rising portion of the next sun spot cycle It outlines a plan to develop a bank for the data and to publish a running account of the findings under a cooperative industry-government effort (Author)

**A77-44436 # Aircraft navigation with the limited operational phase of the NAVSTAR Global Positioning System** L R Kruczynski (U S Air Force Academy, Colorado Springs, Colo.) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 59-68 8 refs Research supported by the Global Positioning System Joint Program Office

In 1980, the NAVSTAR Global Positioning System (GPS) will be in the limited operational phase During this phase, a GPS user will not generally be able to determine his position using satellite measurements only This paper describes the simulation of an aircraft navigation technique which uses the limited operational phase GPS and barometric altimeter measurements For this research effort, the GPS user was assumed to be a cargo-type aircraft equipped with a

single-frequency, sequentially-tracking GPS receiver and a barometric altimeter Such equipment is expected to be relatively inexpensive The flight profile consisted of a New York to Chicago flight and included takeoff and landing maneuvers A small amount of wind gusts were simulated To make the simulation more realistic, random effects were included in the user and satellite clocks, in the atmospheric radio delays, and in the measurement process itself The tested navigation algorithm is based on the well-known Kalman filter equations Three different models of aircraft acceleration were evaluated Results indicate that, for a wide range of filter parameters, navigation errors are generally less than 100 meters Poor geometry, however, results in kilometer-sized position errors. (Author)

**A77-44437 # Helicopter offshore operations** W T Kuhar and G H Quinn (FAA, Navigation Div , Washington, D C ) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 69-71

The sale of lease sites off the U S coast and in Alaska, for oil and gas exploration and production, has resulted in a need for helicopter operations in offshore areas in instrument weather conditions Such operations require an air traffic control system and a navigation capability that will extend to 300 miles from shore, and provide guidance down to 200 feet above sea level Accuracy and reliability must be at least equal to that available with VOR-DME The overall offshore situation is described and FAA and industry efforts to meet the helicopter offshore navigation requirements are explained (Author)

**A77-44438 # Omega system performance predictions.** A D Thompson (Boeing Co , Seattle, Wash ) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 72-81 7 refs

Under normal atmospheric conditions the Omega navigation system provides worldwide coverage with a potentially high index of accuracy To a large degree the achieved performance depends heavily upon the processing algorithm employed in the mobile terminal This dependence is illustrated for two classes of receivers which were configured to emulate hyperbolic regimes based upon alternate station selection criteria Both receiver sets were exercised on a worldwide basis for position fix ensemble sizes of three, four and five transmitter stations Results are given in terms of contours and histograms of the predicted rms position error and capsule statistics of the overall global performance (Author)

**A77-44439 # VLF pulse timing - Limitations and potential as a companion to Omega** R G Brown (Iowa State University of Science and Technology, Ames, Iowa) In National Aerospace Meeting, Denver, Colo , April 13, 14, 1977, Proceedings Washington, D C , Institute of Navigation, 1977, p 82-87 9 refs Research supported by the Iowa State University of Science and Technology

The potential accuracy of VLF pulse (envelope) timing is severely limited by vagaries of the propagation medium and atmospheric noise due to spherics These limitations are discussed in depth The conclusion is that VLF pulse-timing accuracy corresponding to about 5 n mi should be possible over very long ranges up to 5000 n mi A hypothetical system employing pulse transmitters co-located at the Omega sites is explored It is proposed that such a pulse system and the present phase-only Omega system could serve to complement each other as a coarse-fine system (Author)

**A77-44440 An analysis of helicopter rotor response due to gusts and turbulence** M Judd and S J Newman (Southampton, University, Southampton, England) *Vertica*, vol 1, no 3, 1977, p 179-188 8 refs

Analyses are presented for the rotor and vehicle response to gusts and turbulence The nature of helicopter alleviation factors is discussed and the rotor response to sinusoidal gusts is used to build up the aircraft spectral behaviour The formulation of a more

detailed study of step and ramp gust response is described briefly and preliminary results presented (Author)

**A77-44441 Main rotor wake/tail rotor interaction** J W Leverton, J S Pollard, and C R Wills (Westland Helicopters, Ltd, Yeovil, Somerset, England) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, University of Southampton, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 3, 1977, p 213-221 5 refs

An experimental procedure is worked out for isolating the noise resulting from interaction of the tail rotor and vortices shed from the main rotor, to determine the frequency and amplitude characteristics of the interaction noise. A theoretical model is described, and the experimental arrangement, using a ground array of microphones and data from on-board microphones, is also described. Interaction noise signals were difficult to simulate on the computer, and the pulse signal was consistently distorted by the analysis procedures. Reversing the sense of rotation of the tail rotor abated some of the peculiar burbling deep-throated interaction noise. The study is considered applicable to any impulsive or semi-impulsive noise source, some noise sources commonly considered steady-state are actually impulsive in character. R D V

**A77-44442 On the static pressure in the wake of a hovering rotor** A R S Bramwell (City University, London, England) (*European Rotorcraft and Powered Lift Aircraft Forum, 1st, University of Southampton, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 3, 1977, p 223-230 7 refs

One of the basic assumptions of the classical airscrew momentum theory is that the static pressure in the airscrew wake is the same as that of the surrounding air. Consideration of the wake as the air set in motion by the vortex sheets shed by the individual blades leads to the conclusion that, even when the number of blades is infinite, the final wake static pressure is different from that of the surrounding air, in fact, the static pressures are determined by the requirement that the total head should be the same throughout the flow. The difference between the wake and ambient static pressures is greatest when the axial velocity is zero, i.e., for the hovering rotor. A corresponding modification to the momentum theory shows that the ratio of the induced velocity in the wake to that at the rotor is much less than that given by the standard momentum theory, with corresponding increase in the contraction ratio. Tests on a small rotor in the hovering condition confirm that a static pressure difference does exist although it is not so large as suggested by the theory, but this is thought to be due to the fact that the wake from the rotor was probably far from the ideal wake assumed by the theory. The work suggests that a reappraisal of the momentum relationships in hovering flight and at low axial speeds should be made (Author)

**A77-44443 The remotely piloted helicopter** A J Faulkner and I A Simons (Westland Helicopters, Ltd, Yeovil, Somerset, England) *Vertica*, vol 1, no 3, 1977, p 231-238

This article describes some of the fundamental problems associated with current fixed wing remotely piloted vehicles, particularly during launch and recovery, and introduces the idea of a small remotely piloted helicopter in the role of real time surveillance and reconnaissance. It is argued that a co-axially rotated helicopter with a plan-symmetric fuselage is the most suitable configuration for remote piloting as it offers the simplest form of pilot controls, minimises rotor cross-couplings and permits a cartesian mode of operation. The problems associated with the aerodynamic shape of the fuselage are indicated and the importance of automatic stabilization is discussed in some detail. Finally a brief account is given of some experimental flight testing carried out on a small scale co-axial helicopter (Author)

**A77-44444 On the validity of lifting line concepts in rotor analysis** T Van Holten (Delft, Technische Hogeschool, Delft, Netherlands) (*European Rotorcraft and Powered Lift Aircraft*

*Forum, 1st, University of Southampton, Southampton, England, Sept 22-24, 1975*) *Vertica*, vol 1, no 3, 1977, p 239-254

Using the acceleration potential description of flow fields combined with a matched asymptotic expansion technique, a higher-order lifting line theory can be developed which takes into account all the unsteady, yawed flow effects encountered by helicopter blades. This theory points out several errors in the usual lifting line methods of rotor analysis (Author)

**A77-44453 \* # Macroscopic study of time unsteady noise of an aircraft engine during static tests** B J Clark, M F Heidmann, and W J Kreim (NASA, Lewis Research Center, Cleveland, Ohio) *Acoustical Society of America, Meeting, 92nd, San Diego, Calif., Nov 16-19, 1976, Paper 14 p 9* refs

Static tests of aircraft engines can exhibit greater than 10 dB random unsteadiness of tone noise levels because flow disturbances that prevail near test site facilities are ingested. Presumably such changes are related to installation and test site features. This paper presents some properties of unsteady noise observed at a NASA-Lewis facility during tests of a Lycoming YF-102 turbofan engine. Time and spatial variations in tone noise obtained from closely spaced far-field and inlet duct microphones are displayed. Long (0.5 sec) to extremely short (0.001 sec) intermittent tone bursts are observed. Unsteadiness of the tone, its harmonics, and the broadband noise show little similarity. In the far-field, identity of tone bursts is retained over a directivity angle of less than 10 deg. In the inlet duct, tone bursts appear to propagate axially but exhibit little circumferential similarity. They show only slight relationship to tone bursts observed in the far field. The results imply an intermittent generation of random mixtures of propagating duct modes (Author)

**A77-44456 \* # Simulation of flight-type engine fan noise in the NASA-Lewis 9 x 15 anechoic wind tunnel** M F Heidmann and D A Dietrich (NASA, Lewis Research Center, Cleveland, Ohio) *Acoustical Society of America, Meeting, 92nd, San Diego, Calif., Nov 16-19, 1976, Paper 24 p 26* refs

A major problem in the measurement of aircraft engine fan noise is the difficulty of simulating, in a ground-based facility, the noise that occurs during flight. Flight-type noise as contrasted to the usual ground static test noise exhibits substantial reductions in both (1) the time unsteadiness of tone noise and (2) the mean level of tones calculated to be nonpropagating or cut off. A model fan designed with cut-off of the fundamental tone was acoustically tested in the anechoic wind tunnel under both static and tunnel flow conditions. The properties that characterize flight type noise were progressively simulated with increasing tunnel flow. The distinctly lobed directivity pattern of propagating rotor/stator interaction modes was also observed. The results imply that the excess noise attributed to the ingestion of the flow disturbances that prevail near most static test facilities was substantially reduced with tunnel flow. The anechoic wind tunnel appears to be a useful facility for applied research on aircraft engine fan noise under conditions of simulated flight (Author)

**A77-44457 \* # Core noise source diagnostics on a turbofan engine using correlation and coherence techniques** A Karchmer and M Reshotko (NASA, Lewis Research Center, Cleveland, Ohio) *Acoustical Society of America, Meeting, 92nd, San Diego, Calif., Nov 16-19, 1976, Paper 27 p 7* refs

Fluctuating pressure measurements at several locations within the core of a turbofan engine were made simultaneously with far-field acoustic measurements. Correlation and coherence techniques were used to determine the relative amplitude and phase relationships between core pressures at these various locations and between the core pressures and far-field acoustic pressure. The results indicate that the combustor is a low-frequency source region for acoustic propagation through the core nozzle and out to the far-field. Specifically, it was found that the relation between source pressure and the resulting sound pressure involves a 180 deg phase shift and an amplitude transfer function which varies approximately as

frequency squared. This is shown to be consistent with a simplified model using fluctuating entropy as a source term (Author)

**A77-44460 \* # Effects of forward velocity on noise for a J85 turbojet engine with multitube suppressor from wind tunnel and flight tests** J R Stone, J H Miles, and N B Sargent (NASA, Lewis Research Center, Cleveland, Ohio) *Acoustical Society of America, Meeting, 92nd, San Diego, Calif., Nov 16-19, 1976, Paper. 30 p 28 refs*

Flight tests and wind tunnel noise tests using a J85 engine with some representative jet exhaust noise suppressors are reported. Capabilities and limitations of the two types of experimental methods are evaluated with emphasis on investigation of forward velocity effects. The suppressor arrangement was a 104 elliptical-tube nozzle configuration, with or without an acoustically lined shroud. The suppressor noise levels are found not reduced as much by forward velocity as expected for unsuppressed jets. The directivity and forward velocity effects appear more similar to predicted trends for internally generated noise than for unsuppressed jet noise. R D V

**A77-44461 \* # OTW noise correlation for several nozzle/wing geometries using a 5 1 slot nozzle with external deflectors** U von Glahn and D Groesbeck (NASA, Lewis Research Center, Cleveland, Ohio) *Acoustical Society of America, Meeting, 92nd, San Diego, Calif., Nov 16-19, 1976, Paper 28 p 9 refs*

Acoustic spectral data obtained from a model-scale study of several OTW configurations with a 5 1 slot nozzle using various external deflectors are correlated in terms of deflector geometry and flow parameters. Variations in the deflector geometry include deflector size and deflector angle. In addition, geometry variations in flap setting and nozzle chordwise location are included. Three dominant noise sources are correlated: fluctuating lift noise, flap trailing edge noise, and jet mixing noise. Aerodynamic characteristics, including lift and thrust measurements, obtained for the various configurations are summarized (Author)

**A77-44462 \* # Flight effects on exhaust noise for turbojet and turbofan engines - Comparison of experimental data with prediction** J R Stone (NASA, Lewis Research Center, Cleveland, Ohio) *Acoustical Society of America, Meeting, 92nd, San Diego, Calif., Nov 16-19, 1976, Paper 20 p 23 refs*

Recent experiments on the effects of flight on jet engine exhaust noise have produced apparently conflicting results. Some of these results do not agree with projections based on classical jet noise theories nor with experimental results from model jet simulated flight tests. It has been shown that in some of the cases reported, the proper corrections were not made to account for the distributed nature of the jet noise sources. It is shown herein that the remaining discrepancies can be reconciled by considering the combined effects of jet mixing noise, internally generated engine exhaust noise, and shock noise. This paper demonstrates that static and in-flight jet engine exhaust noise can be predicted with reasonable accuracy when the multiple-source nature of the problem is taken into account. Jet-mixing noise is predicted from an improved version of the NASA interim prediction method. Provisional methods of estimating internally generated noise and shock noise flight effects are used, based partly on existing prediction methods and partly on recently reported engine data (Author)

**A77-44513 An interpretation of the Army standard hot day in operational terms** W G Bousman (US Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.) *American Helicopter Society, Journal, vol 22, July 1977, p 10-12*

A technique for interpreting a military helicopter design point, using the US Army standard hot day concept specifying temperature and pressure altitude conditions for successful hover maneuvers by the rotorcraft, is proposed. The method relates the vertical performance capability (VPC) of the machine to the climatology of a selected region using the distribution of hours per day over a year when the aircraft is capable of meeting its specified vertical

performance requirements. Cumulative probabilities of elevation and temperature for the region and VPC as a function of design pressure altitude and temperature and of service time over the year are studied. R D V

**A77-44514 Engine control stabilizing compensation-testing and optimization** J R Alwang (Boeing Vertol Co., Philadelphia, Pa.) and C A Skarvan (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.) *American Helicopter Society, Journal, vol 22, July 1977, p 13-18*

A discussion of engine control compensation for power turbine speed governing system stabilization is presented. Testing of various control compensation techniques in a dynamic helicopter environment is described with analytical correlation between computer simulation and test results. Extrapolation from test to aircraft configuration for defining compensation requirements through the operating extremes is illustrated (Author)

**A77-44515 Emergency-power benefits to multi-engine helicopters.** R D Semple, J H Yost, E W King, J E Gonsalves (Boeing Vertol Co., Philadelphia, Pa.), and W Thompson (US Army, Ballistics Research Laboratory, Aberdeen Proving Ground, Md.) *American Helicopter Society, Journal, vol 22, July 1977, p 27-33*

Emergency power to enable military twin-engine or multi-engine helicopters to recover from emergency situations with one engine inoperative is discussed. Requirements of an emergency power system, cost, test substantiation, operational power checkout, and engine materials assessments (turbine blade life, strength of the materials, turbine blade temperature, and blade-root stress) are studied. Reductions in forced and crash landings, and in forced jettisoning of stores, are obvious benefits, but advantages from safer takeoffs with heavier loads, safe rooftop operations, lower vulnerability to hostile action, and overall system cost reduction are also expected from enhanced engine-out capability. Application of emergency power would necessitate prompt hot-end inspection and replacement of hot engine components. R D V

**A77-44550 Air transport noise reduction** R J Koenig (FAA, Environmental Research Branch, Washington, D C.) *Noise Control Engineering, vol 8, May-June 1977, p 120-130. 41 refs*

Aircraft noise regulation and trends in noise reduction technology are discussed. In particular, the noise abatement program incorporated in the FAA's Five-Year Environmental Plan (1976-80), involving noise reductions at the design level, modification of airport and flight procedures, attainment of compatible land use in airport zones, and retiring or modification of existing aircraft that do not meet noise abatement standards, is considered. Noise level contours for aircraft with low-bypass-ratio and high-bypass-ratio turbofan engines are given, and the FAA rule of 1977 governing takeoff, sideline and approach noise limits is discussed. Aspects of aircraft acoustic design related to jet noise, fan noise, turbine and combustor technology, airframe noise, acoustic treatment of nacelle ducts, mufflers, and aircraft and nacelle configurations are also considered, together with acoustic testing techniques. J M B

**A77-44565 The effect of boundary layer changes due to transient heat transfer on the performance of an axial-flow air compressor** N R L MacCallum (Glasgow, University, Glasgow, Scotland) and A D Grant (Strathclyde, University, Strathclyde, Scotland) *Society of Automotive Engineers, International Automotive Engineering Congress and Exposition, Detroit, Mich., Feb 28-Mar 4, 1977, Paper 770284 10 p 17 refs*

The results of an investigation concerning flow over a hot convex surface are incorporated in an exploratory method for predicting the characteristics of a multistage axial-flow compressor. The application of the method is illustrated with the aid of an example involving the conditions in a compressor at the end of a rapid deceleration at an altitude of 12,200 m from maximum speed to flight idle speed, prior to a possible acceleration. The objective of

the investigation is to predict the change in the characteristics of a real, three-dimensional compressor due to heat transfer G R

**A77-44570** **Position finding using distance measurements (Localisation par mesures de distance)** P Hugon (Institut Français de Navigation, Paris, France) *Navigation* (Paris), vol 25, July 1977, p 269-275 In French

Fairly inexpensive data acquisition and reception devices for obtaining fixes on positions on a great-circle route with measurements of successive phases are discussed. Conditions for reception of LF and VLF emissions from coastline stations and the circuitry of on-board receivers are discussed. Suitable approximations for practical navigation work and estimates of distance error are attended to R D V

**A77-44571** **A special-purpose pocket calculator for aviation and maritime navigation (Une calculatrice de poche spéciale pour la navigation aérienne et maritime)** M Zimeray (Société Sonotec, Paris, France) *Navigation* (Paris), vol. 25, July 1977, p 276-284 In French

The NAV-60 special-purpose pocket calculator dedicated to aviation navigation computation problems is described, and three programs are run through in detail (correction of speed given by DME equipment, combination of current vectors, solving aircraft speed triangle and same adapted to ship navigation) with keystroke sequences indicated and explained. Some of the NAV-60 pre-programmed capabilities are indicated, and the dual-function keyboard (English symbols) with both conventional slide-rule functions and navigation-dedicated functions is described. Direct conversions from deg/min/sec or hr/min/sec to decimals and vice versa, and keys for dead reckoning, VOR fixes, VOR-aided navigation, and rhumb-line navigation, are appreciated, and equivalent interpretations for aviation and maritime navigation are offered R D V

**A77-44572** **Outlook for utilization of the North Atlantic air space in 1978 (Perspectives d'utilisation de l'espace aérien l'Atlantique Nord en 1978)** J Fournier (Compagnie Nationale Air France, Paris, France) *Navigation* (Paris), vol 25, July 1977, p 313-324 In French

Termination of the Loran-A system, new conditions associated with the introduction of the Omega and INS navigational systems, requirements for transatlantic aircraft under MNPS (Minimum Navigation Performance Specifications), and system adjustments and problems are discussed. Training and retraining of crews and of navigators in particular, Omega and INS system errors and adjustments at introduction and in-flight, error detection, and flight analysis are discussed. The navigation systems of Concorde, Boeing 747, and Boeing 707 are described and characterized in this context R D V

**A77-44738** **Software implementation of a PN spread spectrum receiver to accommodate dynamics** C R Cahn, D K Leimer, C L Marsh (Magnavox Government and Industrial Electronics Co., Torrance, Calif.), F J Huntowski, and G D Larue (US Army, Satellite Communications Agency, Fort Monmouth, N.J.) *IEEE Transactions on Communications*, vol COM-25, Aug 1977, p 832-840 8 refs

An experimental project was undertaken to modify an existing ground PN modem (AN/USC-28, ADM version) for flight test. A software implementation of the digital tracking algorithms was selected where a HP-2100A minicomputer controls carrier frequency and PN code phase via digital phase shifters. The Costas demodulator for extracting PSK data resides entirely in software, and is completely segregated from PN tracking. In laboratory testing of the receiver with simulated dynamics and in actual flight tests, the demonstrated performance was found to approach closely the goals established by the analyses and simulations (Author)

**A77-44783** **An electro-optic airspeed sensor** M J Rudd (Bolt Beranek and Newman, Inc., Cambridge, Mass.), G A DuBro, and D G Kim (USAF Dynamics Laboratory, Wright-Patterson AFB

Ohio) In *Electro-optical Systems Design Conference and International Laser Exposition*, New York, N.Y., September 14-16, 1976, Proceedings of the Technical Program Chicago, Industrial and Scientific Conference Management, Inc., 1976, p 384-392 13 refs

The Optical Convolution Velocimeter, an electro-optic airspeed sensor capable of measuring airspeeds from 2 to 120 mph, is described. Flow in the airstream is visualized by a shadowgraph optical system and the speed at which the shadowgraph crosses a grating is measured as a frequency. The shadowgraph optical system, relevant optical theory, and calculations of the signal strength are examined. The velocimeter is an absolute velocity sensor which needs no calibration. The device operates under adverse environmental conditions, is inexpensive since it does not contain high precision or delicate parts, and provides a digital output (frequency proportional to velocity) M L

**A77-44812** **General principles of automatic TV trackers** F J Thomas and C A Winsor (Martin Marietta Aerospace, Orlando, Fla.) In *Electro-optical Systems Design Conference and International Laser Exposition*, New York, N.Y., September 14-16, 1976, Proceedings of the Technical Program Chicago, Industrial and Scientific Conference Management, Inc., 1976, p 683-694

Various techniques of electro-optical signal processing have been developed to provide fire control and missile systems with an automatic tracking capability. Of particular interest are those tracker concepts that have been developed to operate with real-time imaging systems, especially those compatible with standard television formats. This paper reviews the general principles of automatic TV trackers and examines similarities and differences in such areas as tracking aperture, video processing concepts, and error detection algorithms. In addition, performance metrics and system applications are briefly discussed (Author)

**A77-44814** **Scanned laser visual system** C R Driskell (US Army, Orlando, Fla.) and A M Spooner (Redifon Flight Simulation, Ltd., Crawley, Sussex, England) In *Electro-optical Systems Design Conference and International Laser Exposition*, New York, N.Y., September 14-16, 1976, Proceedings of the Technical Program Chicago, Industrial and Scientific Conference Management, Inc., 1976, p 738-743

A description is presented of an advanced, high-resolution wide-angle visual system for military flight simulation. The laser camera of the system employs two high power ion lasers, including an argon laser to provide green and blue primary colors and a krypton laser to supply the red primary color. The output beams from the lasers are combined and fed to the laser camera with the aid of fiber-optics components. Attention is given to aspects of image generation, a description of the laser visual system, the field of view and resolution, the optical layout, problems of focussing, and aspects of attitude control G R

**A77-44815** # **A new concept of static stability and its flight testing in supersonic flight** G Sachs (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Journal of Aircraft*, vol 14, Sept 1977, p 874-880 13 refs

The current concept of static stability is not adequate for supersonic flight since it does not account for the influence of forces and moments due to altitude perturbations, which have a significant effect on the longitudinal motion. A new concept is proposed that accounts for altitude influence in an adequate manner. This concept, which is closely related to constant energy consideration, is based on a dynamic stability analysis with particular reference to the exponential characteristic modes of the airplane. Furthermore, it is shown that the well-known relation between static stability and the variation of elevator angle with speed is not valid in supersonic flight. As a consequence, the flight test methods currently used for determining static stability also are not adequate for supersonic flight. A new flight test method is proposed that provides an

indication of static stability using the variation of elevator angle with altitude (or dynamic pressure, respectively) The points addressed may be of particular significance in regard to existing flying qualities requirements and criteria (Author)

**A77-44816 # An investigation of the near-field wake behind a full-scale test aircraft** L J Mertaugh, R B Damania (Mississippi State University, Mississippi State, Miss), and F L Paillet (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *Journal of Aircraft*, vol 14, Sept. 1977, p 894-902 10 refs Contracts No F33615-72-C-1052, No F36615-74-C-3066

Three-dimensional velocity field measurements were made on three transverse measurement planes located at 7.7, 33.3, and 61.2 in behind the inboard wing trailing edge of an aircraft in flight The test aircraft featured a distributed suction boundary-layer control system Test data were obtained at various lift coefficients and with both zero and full flap deflections Flowfield measurements were made with a total-vector hot-film probe mounted to a boom and traversing mechanism attached to the rear fuselage of the test aircraft The velocity measurements allowed computation of all three components of vorticity at the 7.7-in plane and the normal (to the measurement plane) component of vorticity at the other two planes The test results are presented as a series of contours of the various vorticity component values in the measurement planes The formation of a concentrated core of axial vorticity is noted The test data are also compared to the predictions of a two-dimensional inviscid wake calculation based on measured wing loading for the L-19

(Author)

**A77-44817 \* # Streamtube analysis of a hydrogen-burning scramjet exhaust and simulation technique** N A Talcott, Jr and J L Hunt (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va) *Journal of Aircraft*, vol 14, Sept 1977, p 918-920 7 refs

A scramjet/airframe integration program and a technique for simulating thermally perfect scramjet exhaust flows (freon/argon gas blends) is studied to extend the technique to more complicated flows approaching the actual exhaust flow in complexity The state of the flow and the accuracy of the substitute gas simulation are analyzed in the case of a shock discontinuity present Findings are: scramjet exhaust flow is essentially frozen throughout the expansion at Mach 6 and Mach 8, flow behind moderate shocks remains frozen, the technique can accurately track static distributions in scramjet exhaust flows (shocked or unshocked) R D V

**A77-44818 # Comparative flutter calculations for the Viggen aircraft** V J E Stark (Saab-Scania AB, Linköping, Sweden) and D E Cooley (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *Journal of Aircraft*, vol 14, Sept 1977, p 920, 921 11 refs

Aeroelastic calculations for the canard wing configuration of the Saab-Scania Viggen are discussed, with three-dimensional effects and interference effects taken into cognizance Linear combinations of given functions of two variables were fitted by the method of least squares to measured modal deflections, one combination was determined for each trapezoidal wing panel The given functions are products of chordwise and spanwise factors special polynomials with vanishing 2nd-order and 3rd-order derivatives at free panel edges Discontinuous deflection functions can be employed to obtain control surface deflections This and a variant method produced results in close agreement While a large flutter margin is predicted, the results apply to zero angle of incidence R D V

**A77-44819 # Leading-edge vortex effect on the flutter speed** V J E Stark (Saab-Scania AB, Linköping, Sweden) *Journal of Aircraft*, vol 14, Sept 1977, p 921, 922 7 refs

An approximate method developed by Pines (1958) for predicting a reduction in the flutter speed brought about by vortex effects is reconsidered A small flutter frequency is not assumed A correction factor devised effected a significant increase in predicted flutter speed, the flutter speed reduction due to leading-edge vortex effect is

plotted A satisfactory flutter margin is shown to remain in spite of the possible reduction brought about by the vortices R D V

**A77-44824 # Characteristic time emissions correlations - The T-63 helicopter gas turbine combustor** A M Mellor (Purdue University, West Lafayette, Ind) *Journal of Energy*, vol 1, July-Aug 1977, p 257-262 11 refs US Environmental Protection Agency Grant No R-802650

Gaseous pollutant emissions from conventional diffusion flame T-63 combustors are correlated as functions of combustor geometry and inlet conditions in terms of a characteristic time model New aspects of the present study show partial inclusion of effects of alternate fuel properties, suggest a generalization of the Lipfert NO(x) correlation, compare advanced film injected and prevaporizing/premixing with conventional combustors, and demonstrate a quantitative relation between emissions of unburned hydrocarbons and CO (Author)

**A77-44946 \* # Generalized Theodorsen solution for singular integral equations of the airfoil class** M H Williams (Princeton University, Princeton, N J) *Quarterly of Applied Mathematics*, vol 35, July 1977, p 213-224 10 refs Grant No NGR-31-001-197

A class of singular integral equations is considered which arise in various two-dimensional mixed boundary-value problems with simple harmonic time variation A problem typical of this class is that of determining the lifting pressure distribution on an oscillating airfoil in an unbounded incompressible potential flow It is shown that Theodorsen's (1935) solution to this problem, with some modification, is valid for a general class of unsteady kernel functions The technique employed is to consider an equivalent steady problem and then show that the unsteady resolvent and unsteady homogeneous solution can be written directly in terms of the steady solutions and a single frequency-dependent function which reduces to the Theodorsen function for the steady kernel P T H

**A77-44957 # ONERA aerodynamic research work on helicopters** J-J Philippe and C Armand (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Symposium on Rotorcraft Design, Moffett Field, Calif., May 16-19, 1977) ONERA, TP no 1977 42E, 1977 20 p 35 refs

Research involving two- or three-dimensional flows and studies on rotors are surveyed Some basic research topics include an airfoil study in steady flow, the unsteady performance of airfoils, a blade tip study in steady flow, and a vortex interaction wind tunnel simulation The principle of the method used for calculation of the forces acting on the rotor is described and applied to the cases of a rigid blade rotor and a flexible blade rotor Two rotor test rigs, one located in an 8 m wind tunnel, the other located in a 3 m wind tunnel, are considered Measuring techniques and results for total forces on helicopter or convertible, absolute pressures on the blades, identification of the boundary layers, smoke visualizations, and rotating blade deformations are examined M L

**A77-44959 Technology comes to general aviation** *Flight International*, vol 112, Aug 27, 1977, p 617-620, 627, 628

The paper reports on various studies being undertaken by NASA for the development of advanced technology, already available to modern military aircraft and commercial transports, for the lighter aircraft of general aviation These studies include the supercritical wing, airframe drag reduction, crashworthiness, spin resistance, turbine engines, quiet propellers, and improved autopilots P T H

**A77-45171 # Feasibility demonstration of the earth referenced maneuvering flight path display** J F Watler, Jr (Northrop Corp., Hawthorne, Calif) and W G Mulley (US Naval Material Command, Naval Air Development Center, Warminster, Pa) *American Institute of Aeronautics and Astronautics, Guidance and Control Conference, Hollywood, Fla., Aug 8-10, 1977, Paper 77-1114* 9 p

A description is presented of the maneuvering flight path display concept The concept was formulated under Navy sponsorship during

the period from 1952 to 1963. The concept was developed in response to three basic requirements, including greater aircraft weapon system performance, increased flight safety, and decreased pilot training. The maneuvering flight path display provides both command and actual guidance and control information to the pilot. Attention is given to details regarding the development of the flight path display, a feasibility demonstration, deviations from the flight path during the landing approach, and pilot workload levels during the landing approach. G R

**A77-45173**      **Operational reliability and reliability testing**  
Mt Prospect, Ill., Institute of Environmental Sciences, 1977. 76 p.  
\$6.00

Reliability standards and reliability testing of avionics components and aircraft are discussed. Topics of the papers include implementation of a complete reliability testing program and modification of inadequate environmental, electronics and vibration monitoring, the operational influences on avionics reliability, studied through mathematical modeling and field data, the Combined Environments Reliability Testing (CERT) used by the U.S. Air Force Flight Dynamics Laboratory to evaluate components of high-performance aircraft, an analysis of discrepancies between laboratory-test performance and operational performance of avionics components, criteria for the formulation of adequate vibration tests, the detection of latent defects through vibration testing, and the use of statistical decision theory to assess cost-effective vibroacoustic test plans applied to the Space Shuttle. J M B

**A77-45387**      **Nonlinear lifting-surface theory for yawed and banked wings in ground proximity (Nichtlineare Tragflächentheorie für schiebende und hangende Flügel in Bodennahe)** G. Binder (Braunschweig, Technische Universität, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, July-Aug. 1977, p. 241-249. 24 refs. In German.

For wings with arbitrary planform in ground proximity, placed at an angle of yaw with respect to the free stream and at an angle of bank relative to the ground plane, the aerodynamic characteristics are calculated by means of lifting-surface theory. The ground effect is taken into account using the image technique. The vortex systems of the real wing and of the image wing are inclined against the ground plane. The perturbation velocities induced by the image wing are taken into consideration completely using the methods of K. Gersten and D. Hummel. A comparison of the theoretical results with experimental data shows that the aerodynamic characteristics of wings in unsymmetrical flow near the ground are well predicted by the theory. (Author)

**A77-45388**      **The theoretical determination of the base pressure in supersonic flow (Theoretische Bestimmung des Basisdruckes bei Überschallströmung)** M. Tanner (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, July-Aug. 1977, p. 249-259. 35 refs. In German.

The reported investigation is concerned with an extension of the theory for the determination of the base pressure in the case of a two-dimensional nonperiodic dead water flow developed by Tanner (1972, 1973). The theory in its previous form is only valid for compressible flows without shock waves. The extended theory is to take into consideration also an occurrence of shock waves. The basic concepts of the theory are discussed for two-dimensional flow and for axisymmetric flow. The velocity and density distribution in the wake is examined and the effects of the various factors on the base pressure are considered. The results obtained with the aid of the new theory are found to agree with experimental data in a number of cases. G R

**A77-45391**      **Experience gained in adjusting the mathematical model of the VFW 614 short-haul aircraft by use of measured eigenfrequencies (Erfahrungen zur Korrektur des Rechenmodells mit gemessenen Eigenfrequenzen am Beispiel des Verkehrsflugzeugs VFW 614)** H. Zimmerman, D. Collmann

(Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany), and H. G. Natke (Hannover, Technische Universität, Hannover, West Germany). *Zeitschrift für Flugwissenschaften und Weltraumforschung*, vol. 1, July-Aug. 1977, p. 278-285. 6 refs. In German.

A procedure is presented which provides a means for adjusting computed characteristic quantities of natural modes of vibration of an elastomechanical structure to fit measured ones. By minimizing the square of the difference between computed and measured kinetic energy an appropriately weighted and normalized expression is derived which contains only measured eigenfrequencies and no measured mode shapes, i.e., the fit is performed for quantities which can be measured very accurately. The equations that are used show that the computed mode shapes are improved at the same time. The procedure was applied to practical examples in order to gain experience with it. The passenger aircraft VFW 614 especially was subjected to detailed investigations. These showed that the method may not be used in the manner of an automatic procedure. In particular a careful selection and assignment of measured frequencies is necessary. In some cases an iterative repetition of the procedure is required. (Author)

**A77-45460**      **A tryout of a rigid airship under tropical conditions (Erprobung eines Prallluftschiffs unter tropischen Bedingungen)** H.-P. Barthelt and R. Roth (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, West Germany). *DFVLR-Nachrichten*, July 1977, p. 852-855. In German.

An investigation was conducted concerning the possibility to use airships for an alleviation of transport problems in developing countries with a weak infrastructure. The investigation included the operation of an airship in the African states of Ghana and Upper Volta. Flights were made between Accra, Kumasi, and Ouagadougou. The results of the investigation show that the employment possibilities of airships for the solution of transport problems in countries with a weak infrastructure are mainly limited by the characteristics of the airship itself. The maintenance of a state of floating in a certain position appears difficult, taking into account the necessity to compensate for environmental effects and changes regarding the airship-related parameters. G R

**A77-45491**      **Interactive graphics in aircraft gas turbine engine design** E. N. Nilson (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). In *Interactive computer graphics in engineering*, Proceedings of the Winter Annual Meeting, New York, N.Y., December 5-10, 1976. Meeting sponsored by the American Society of Mechanical Engineers, New York, American Society of Mechanical Engineers, 1977, p. 58-69. 5 refs.

Applications of computer interactive graphics in the design of aircraft gas turbine engine components are discussed and illustrated. Libraries and shared data bases for interactive programs and modifications of programs, finite-element mappings of turbine blades, forging die lines for fan blades in perspective view, and longitudinal sections through engines are exhibited as typical displays. Drastic reductions in design and development lead time are recognized as the major driving force in acceptance of interactive graphics. Continuous rotation, zooming, translation, rotation, and perspective in apparent 3D format, allowing see through, exploded, or opaque views, are noted among the advantages of interactive graphics. R D V

**A77-45501**      **Effects of technology level on V/STOL aircraft** S. G. Kalematis and R. A. Cea (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug. 22-24, 1977, Paper 77-1238*. 5 p.

Two V/STOL fighter aircraft were postulated for a mid/late-80's IOC (initial operational capability), based on low-risk technology forecasts. The larger of the two aircraft represented the upper-middle range of the Hi-Low spectrum, the smaller aircraft represented the



low-middle range. The effect of variations from the projected technology on aircraft performance were calculated. It is shown that for a VTOL aircraft, the most critical factors are empty aircraft weight and losses in lift due to reingestion and engine-airframe interference. All other areas of design can be subordinated to these factors in the pursuit of a viable aircraft. V P

**A77-45502 # Preliminary design and analysis of advanced military transports** E A Barber, L W Noggle (Boeing Aerospace Co., Seattle, Wash.), and I H Rettie (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1224* 9 p

Design solutions for a strategic airlift mission of 3600-nmi radius and 400,000-lb payload are examined. Various design criteria are considered, including life cycle cost, direct operating cost and fuel efficiency. Emphasis is given to comparisons of various body cross sections. A 1985 technology base is established, and the impact of advanced technology and design is evaluated. The implications of commercial commonality with a military transport are discussed.

(Author)

**A77-45503 # The timing of technology - Commercial transport aircraft.** J E Steiner (Boeing Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1200* 17 p

An investigation is conducted of the factors that control the acquisition and the technology of new aircraft, taking into account the current situation and the potential of about 100% improvement in passenger miles per gallon over the pre-1970 aircraft. It is pointed out that the combination of traffic growth and replacement of the older, less efficient, and noisier aircraft brings with it opportunity for technological infusion. Attention is given to the composition of the open market, the U S aircraft obsolescence situation, the U S cyclic buying situation, the noise regulation situation, the significance of new technology, long-term technological benefits, technology applicable to the next generation, and the magnitude of the next buying cycle. G R

**A77-45505 # Advanced Technology Wing /ATW/ selection and design** J R Ellis and J L Maris (Vought Corp., Dallas, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1210* 6 p

Two full scale structural wing boxes of advanced design will be fabricated and tested in this advanced development program. The designs were selected from candidate wing box concepts that were rated for cost, weight, technology improvement, damage tolerance, and the 'abilities'. The selected wing concepts are presented and discussed. Development testing is underway on this program and significant tests and test results are reviewed. Final wing box design drawings are scheduled to be released in mid-August 1977. Fabrication of both demonstration articles is scheduled for completion in mid-September 1978 with testing complete by February 1979.

(Author)

**A77-45506 # Results of a feasibility study to add canards and ADEN nozzle to the YF-17** H R Wasson, G R Hall (Northrop Corp., Hawthorne, Calif.), and J L Palcza (US Naval Air Propulsion Test Center, Trenton, NJ) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1227* 10 p. Contract No. N00014-76-C-1411

The paper deals with an aerodynamic analysis and design feasibility study concerning the addition of canards and the 2 D ADEN (augmented deflecting exhaust nozzle) to the YF-17 aircraft. The results of the aerodynamic study showed that addition of the ADEN nozzle and canards did little to improve the turn rate and trimmed lift-drag polars. They did provide considerable direct lift control and aircraft pointing capability, as well as increased control and increased pitch rate at low dynamic pressure. The design

feasibility study showed that addition of the ADEN nozzle and canards is readily achievable through structural modifications and modifications of the aircraft control system (using existing actuators). Taking into consideration the structural, weight, and control system requirements, the size of the canards could be reduced to 75 ft of included area, making it possible to accommodate the canard without increasing the aircraft gross weight significantly and to remain within the stability limits imposed by the modified control system. V P

**A77-45507 # Vectored-engine-over-wing configuration design** P D Whitten and R W Woodrey (General Dynamics Corp., Fort Worth, Tex.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1228* 8 p

A Vectored-Engine-Over-Wing (VEO-Wing) aircraft configuration designed for an advanced tactical aircraft mission is presented. Engineering data developed for this powered-lift concept illustrates its design features. Aircraft performance estimates are presented to measure the capability of the concept for the tactical role. (Author)

**A77-45508 \* # Aerodynamics of horizontally-opposed aircraft engine installations** S J Miley, E J Cross, Jr., D L Lawrence, and J K Owens (Mississippi State University, Mississippi State, Miss.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1249* 10 p. 9 refs. Grant No. NSG-1083

The goal of cooling installation design is to provide adequate cooling air flow to the engine with a minimum drag penalty. To achieve this goal, attention must be given to certain aerodynamic factors involved in the design problem. In the present paper, the factors which influence the aerodynamic design of horizontally-opposed engine cooling installations are discussed with particular reference to the performance of the aircraft in terms of the dynamic pressure generated for the power output of the engine, the gains or losses through the propeller, proper inlet design, altitude effects on the orifice characteristics of the engine, and exit area sizing. Results of a flight research program showed that the inlet design has a significant influence on cooling effectiveness and drag; the inlet should be designed for low velocity ratios and should avoid small radii of curvature in its geometry. The influence of the propeller on the inlet appears to cause the stagnation point on the lip to move toward the inside. V P

**A77-45509 # The use of probability analysis in aircraft certification and its effects on maintenance and equipment maintenance** J J Treacy (FAA, Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1256* 5 p

The paper surveys the procedures, particularly the use of numerical probability analysis, which the Federal Aviation Administration expects to use in finding compliance with Federal Aviation Regulation (FAR) 25.1309 as amended by Amendment 25-23. A new draft of the 'Systems Design Analysis' Advisory Circular is also described. The use of numerical probability analysis in the certification of the 747 Automatic Ground Rollout System and the 727 Automatic Performance Reserve System is reviewed, and maintenance and reliability requirements are considered. M L

**A77-45510 # Compliance with amended FAR 25.1309 - DC-10 case history** V Vanakojis (Douglas Aircraft Co., Long Beach, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1257* 6 p. 5 refs

The Douglas DC-10 Automatic Landing System was certified in accordance with the requirements of Advisory Circular 120-28, complying with the intent of all requirements of FAR 25.1309 as changed by Amendment 25-23. The design, analysis, and test of the Automatic Landing System was impacted by the regulatory agency interpretations of these requirements. Methods in analysis and testing

were developed to show compliance with the 'extremely improbable' fault criteria for single and/or multiple failures within the automatic pilot, sensors, and peripheral equipment comprising the Automatic Landing System. The numerical probability analysis was used extensively to support the overall design and resulted in some reliability requirements and special tests for the Automatic Landing System. (Author)

**A77-45511 # Control of rare events by aircraft system design regulation - Impact on operations** H F Heap, F S Nowlan (United Air Lines, Inc., San Francisco, Calif.), and J L Dolby (San Jose State University, San Jose, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1258* 5 p.

A situation is encountered with certain aircraft systems where it may be possible for a relatively unlikely sequence of failures to cause a loss of the system's function that will have consequences that are critical to the operating safety of the airplane. This paper discusses the difficulties that the control of rare events by the proposed system design regulation would cause operators. First, the rationale of the design incident rate of 10 to the -9th is examined. Next, this number is put in perspective by a review of United States air carrier safety statistics. Then, maintenance capabilities are reviewed, and the nonproductive activities that these regulations would force on an airplane operator are identified. (Author)

**A77-45512 # YC-14 flight test results** R L McPherson (Boeing Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1259* 8 p. 7 refs

Two YC-14 prototypes were built as part of the Air Force's Advanced Medium STOL Transport program. The flight test program was conducted by the Joint Test Force comprising The Boeing Company, the Air Force Flight Test Center, and the Air Force Test and Evaluation Center, with participation by NASA. The primary purpose of the flight test program was to evaluate a unique form of powered lift referred to as upper surface blowing (USB). The test program began with the first flight on August 9, 1976, and lasted one year. This paper summarizes the flight test activities by discussing the development, envelope expansion, and operational use, and emphasizes the performance and stability and control test results. (Author)

**A77-45513 # Central integrated test system /CITS/ - Check three times** K Derbyshire (Rockwell International Corp., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, Seattle, Wash., Aug 22-24, 1977, Paper 77-1260* 11 p.

The highly sophisticated onboard test system described was developed for the B-1 aircraft. Its implementation is based on the use of an onboard digital computer and a stored real-time software program to control the data acquisition, data processing, and data discrimination operations for performing the B-1 aircraft tests. The system automatically and continuously tests the operability of the aircraft subsystems; the basic approach involves making a pre-programmed decision based on the outcome of a specific test. In the nonavionics computer program, over 4000 fully automatic tests are performed each second. The system has the capability to output, display, and record in excess of 1250 malfunction codes that provide fault detection/isolation information for over 1000 nonavionics LRU's (Line Replaceable Units). The present stage of development of the test system, the implementation and verification of the hardware and software, flight test utilization, and the planned use of the CITS in an operational environment are discussed. V P

**A77-45524 Active control technology** A Simpson (Bristol, University, Bristol, England) and H P Y Hitch (British Aircraft Corp., Weybridge, Surrey, England) *Aeronautical Journal*, vol 81, June 1977, p 231-246 35 refs

Active Control Technology (ACT), defined as the use of conventional single-output feedback control systems in a multi-input,

multi-output role to improve aircraft performance and decrease overall cost, is discussed. Aspects of ACT as applied to fixed-wing craft, including aerodynamic stability requirements, ride improvement, internal load distribution, gust load alleviation, flutter speed enhancement, center of gravity control, envelope limiting and fatigue reduction, are considered. ACT functions as applied to rotorcraft, including mechanical linkages between the pilot control and the cyclic pitch-producing mechanisms, as well as longitudinal and latitudinal controls, are also mentioned. Advances in ACT, such as the development of multivariable multi-input adaptive controls, the use of redundant (e.g., quadruplex) design to achieve system reliability, and the introduction of digital computers, miniaturized electronics and electrohydraulic valves, are reviewed. Research into the aerodynamics of unusual surfaces, the aerodynamics of conventional controls operating at high frequencies, and mathematical modeling of the compatibility of ACT functions is suggested. J M B

**A77-45525 The measurement of performance, stability and control characteristics of a high subsonic jet aircraft in non-steady flight conditions employing high accuracy instrumentation techniques** J A Mulder (Delft, Technische Hogeschool, Delft, Netherlands) *Aeronautical Journal*, vol 81, June 1977, p 247-258 15 refs

**A77-45719 Validation of an airport simulation model.** J F Gilsinn (National Bureau of Standards, Applied Mathematics Div., Washington, D C.) In Winter Simulation Conference, 8th, Gaithersburg, Md., December 6-8, 1976, Proceedings Volume 1

New York, Institute of Electrical and Electronics Engineers, Inc., 1976, p 273-277 8 refs

This paper describes the validation of an airport simulation model, called DELCAP for DELay CAPacity, the two quantities which it measures, for use in estimating the traffic rates attainable at major busy US airports. The simulation model outputs are compared to those of other models for simple cases to which both apply and to actual throughput data for several airports, with differences usually less than 6 to 8 percent. (Author)

**A77-45871 ECM methods for aircraft engine manufacture** G R Dearth (General Electric Co., Fairfield, Conn.) *Society of Manufacturing Engineers, Paper MR76-705, 1976* 19 p

Production-tested applications of electrochemical machining to the manufacture of aviation engine system parts, in bulk removal and in shaping of hard-to-machine materials, are reviewed briefly. Definitions are presented for electrochemical machining, electrochemical (electrolytic) grinding, shaped tube electrolytic machining, electrostream jet impingement techniques, and static electrochemical machining, and their optimum applications are mentioned. Requirements for proper and economic utilization of electrochemical metal removal operations are stated. R D V

**A77-45925 Fuel conservation through airplane maintenance** *Exxon Air World*, vol 29, no 3, 1977, p 64-69

Maintenance (or restoration) of an aerodynamically clean aircraft surface and its payoff in minimizing drag, and concomitantly contributing to holding fuel cost increases down, are discussed. Out-of-flush rivet heads and seals, skin joints protruding into the airflow, leaks, door misalignment, rough skin patches, and dents can add to drag and result in fuel burn penalties. While contributions from any of these factors may be minimal, they can add up and interact. Fuel burn penalties are figured against maintenance/repair costs for many such items, and accounting experience shows sizable savings through maintenance of aerodynamic cleanliness. The 'top ten' drag-enhancing and fuel-penalty problems are listed, and some representative irregularities are illustrated. R D V

**A77-46136 \* The computer for design and optimization** G N Vanderplaats (NASA, Ames Research Center, Moffett Field, Calif.) In Computing in applied mechanics, Proceedings of the Winter Annual Meeting, New York, N Y., December 5-10, 1976

New York, American Society of Mechanical Engineers, 1976, p 25-48 69 refs

Computerized design using numerical optimization techniques is discussed and guidelines for writing analysis computer codes that can be readily coupled to optimization codes are presented. The following numerical optimization techniques are examined: random search, sequential unconstrained minimization, direct constrained optimization, and one-dimensional search. A number of design applications are considered including high speed airfoil lift maximization, the preliminary design of a wing, design of a planar tower for optimal geometry, and the conceptual design of a tactical fighter aircraft. B J

**A77-46262** Stereographic projections in air traffic control systems. E D Gingerich (Raytheon Co., Goleta, Calif.) *Navigation*, vol 24, Summer 1977, p 95-101 5 refs

The mathematical technique chosen to present targets from many radars on a single two-dimensional plane is discussed. Definitions and orientations with respect to longitudes, latitudes, and mathematical coordinate systems are contained in Section 2. Supporting diagrams are also included. The derivation of projection equations from earth points to coordinates in the stereographic plane, and the rotation of radar azimuth into the systems plane to compensate for the varying orientation of North in different radar planes, and the derivation of the equations for mapping a radar target from a radar plane to a systems plane are presented. (Author)

**A77-46263 \*** A digital goniometer for VOR. S A Meer (NASA, Goddard Space Flight Center, Greenbelt, Md.) *Navigation*, vol 24, Summer 1977, p 102-111 6 refs

A new VOR (VHF omnirange) goniometer design which promises to improve the reliability and maintainability of the VOR ground station is described. The heart of the new concept is the use of two digital phase shifters to produce the rotating figure-of-eight pattern of conventional VOR. Using digital circuits, the goniometer adjustments and calibration reduce to timing adjustments of binary signals. A common clock used for timing the digital phase shifters also synchronizes the 30 Hz modulation of the 9.96 kHz reference. (Author)

**A77-46264** RNAV control for airborne surveys. A N Fiori (NOAA, National Ocean Survey, Rockville, Md.) (*Institute of Navigation, Annual Meeting, 31st, Washington, D C, June 24, 1975*) *Navigation*, vol 24, Summer 1977, p 132-141 7 refs

This paper describes the theory, development, and use of a Computer Generated Area Navigation (RNAV) Waypoint Grid System for airborne surveys. Control for these surveys is provided by aircraft equipment utilizing the VOR/DME navigation facilities of the National Airspace System. Bearings and distances (waypoints) from existing facilities are generated by a computer program using coordinate search and geodetic computation techniques from a navigation facility data base. The resultant waypoint grid data, in a form easily used in the aircraft's RNAV equipment, provides accurate position and guidance information for the survey. (Author)

**A77-46348 #** Numerical modeling of helicopter piloting (Modelowanie pilotazu śmigłowca metoda numeryczna). K Szumanski *Instytut Lotnictwa, Prace*, no 67, 1976, p 3-32 10 refs. In Polish

An approach to digital simulation of helicopter piloting and helicopter maneuvers is worked out in detail. Time intervals are subdivided into narrower and narrower slices, with the helicopter equations corrected for each successive step, so that data describing the maneuver can be acquired without violating maneuver constraints. A model of helicopter dynamics in unsteady flight is elaborated and characteristics of subunits of the digital model are described. Several subroutines are discussed, for dealing with power requirements in unsteady flight conditions, lift rotor drive, system equilibrium, narrowing the grid mesh, pilot-machine interaction, an illustrative example is discussed. R D V

**A77-46349 #** Static electricity in aviation and ways of averting its effects (Elektryczność statyczna w lotnictwie oraz sposoby zabezpieczenia przed jej skutkami). K Zuchowicz *Instytut Lotnictwa, Prace*, no 67, 1976, p 33-46 17 refs. In Polish

Effects of static electricity on aircraft in flight are reviewed. Charging mechanisms (via self-charging or induction) and modes of discharge (corona, spark, ribbon), static electricity effects on the functioning of electronic on-board equipment, and ways of coping with accumulation of static charges are discussed. Devices for discharging static electricity and optimum placement of such devices at strategic points on the fuselage are described. R D V

**A77-46401** Gas turbines - Status and prospects, Proceedings of the Symposium, London, England, February 4, 5, 1976. Symposium sponsored by the Institution of Mechanical Engineers, London and New York, Mechanical Engineering Publications, Ltd. (I Mech E Conference Publications, No 1976-1), 1976 164 p \$27

Aspects of gas turbine evolution are considered along with the status and the prospects of the aircraft gas turbine, the design of gas turbines for the industrial and the marine field, the airline viewpoint, gas turbines in the RAF from a maintenance engineering viewpoint, the Royal Navy's experience with main propulsion gas turbines, the status and prospects of the industrial gas turbine, and the designer's dilemma with unmanned controls and the gas turbine user. Attention is also given to a new maintenance concept applied in the design of a new industrial gas turbine in the 100 MW class, experience with gas turbines in the field by a British petroleum company, gas turbines in a powered distribution system, monitoring for preventive maintenance in the small fleet, gas turbine power for large hovercraft, and the gas turbine in the gas transmission environment. G R

**A77-46403** The aircraft gas turbine - Status and prospects. R M Denning and T Jordan (Rolls-Royce /1971/, Ltd, Bristol Engine Div., Bristol, England) In Gas turbines - Status and prospects, Proceedings of the Symposium, London, England, February 4, 5, 1976. London and New York, Mechanical Engineering Publications, Ltd., 1976, p 17-26.

A review is conducted of the effects of the evolution of the gas turbine on subsonic transport aircraft. Future improvements in fuel economy are considered, taking into account propulsive efficiency changes, gas producer thermal efficiency changes, and component efficiency improvements. Aspects of aero-mechanical design for low cost and weight are considered along with environmental factors in engine design, questions of maintenance and reliability, condition monitoring, and turbine blade life. G R

**A77-46405** The airline viewpoint. C B Redgate (British Airways, Overseas Div., London, England) In Gas turbines - Status and prospects, Proceedings of the Symposium, London, England, February 4, 5, 1976. London and New York, Mechanical Engineering Publications, Ltd., 1976, p 35-48.

A description is presented of the lines of action taken by a British airline to reduce operating costs and improve safety standards. Attention is given to maintenance considerations, aspects of reliability, questions of maintainability, and engine maintenance cost. Details of engine health monitoring are discussed, taking into account visual external inspections, internal inspection by borescope, X-ray and isotope techniques, ultrasonic and eddy current techniques, oil systems monitoring, flight deck instrument monitoring, engine performance trend plotting, and airborne integrated data systems. G R

**A77-46406** Gas turbines in the RAF from a maintenance engineering viewpoint. W H Dainty (RAF, London, England) In Gas turbines - Status and prospects, Proceedings of the Symposium, London, England, February 4, 5, 1976. London and New York, Mechanical Engineering Publications, Ltd., 1976, p 49-55.

The current size and cost of the RAF aircraft gas turbine fleet is reviewed against the background of the military operational and

environmental requirements. Developments leading to improvements in performance, and trends in reliability and overhaul life are reviewed. The latest approaches to the adoption of new maintenance policies and engine fleet management are described, following an examination of the economics of military operations, in the light of increasing operating and maintenance costs. The potential for further economies is shown to be greatly enhanced by adopting new maintenance concepts made possible by EHM techniques and the latest breed of modular gas turbines (Author)

**A77-46411** Monitoring for preventive maintenance in the small fleet. D. C. Johnson and D. Dickinson (British Airways, Barry, Wales). In: Gas turbines - Status and prospects, Proceedings of the Symposium, London, England, February 4, 5, 1976. London and New York, Mechanical Engineering Publications, Ltd., 1976, p. 105-115.

The performance of gas turbine engines in service can be monitored with a view to failure prevention using relatively simple and inexpensive techniques readily available to the small fleet operator. A description of important parameters to be monitored and how this may be achieved is given. Application of monitoring programmes to two current engines is described and the improvements in the reliability and economics illustrated (Author)

**A77-46412** Gas turbine power for large hovercraft. P. A. Yerbury (British Rail Hovercraft, Ltd., Dover, England). In: Gas turbines - Status and prospects, Proceedings of the Symposium, London, England, February 4, 5, 1976. London and New York, Mechanical Engineering Publications, Ltd., 1976, p. 117-124.

Economic competition considerations related to ships determine the overall cost levels which are acceptable for hovercraft and, in turn, the proportion that can be allocated to the power unit. In this connection, ultimate gas turbine performance may have to be sacrificed to a certain extent to obtain the appropriate economic conditions. The selection of a gas turbine for a craft employed on the Dover to Boulogne cross-channel route is discussed along with certain difficulties related to corrosion attack. Approaches used to overcome the initial problems are discussed. Attention is given to hovercraft gas turbine requirements and the importance of air filtration, gas turbine design modifications, corrosion resistance within the engine, the part played by the operator, the life development program, and financial considerations. G. R.

**A77-46494** # The design of complex navigation systems (Proektirovaniye slozhnykh navigatsionnykh sistem). L. Ts. Lipchin. Moscow, Izdatel'stvo Mashinostroyeniye, 1976. 176 p. 79 refs. In Russian.

Theoretical and technological aspects of the design and fabrication of airborne navigation systems are covered. Operating principles, analysis of the design of navigational computing systems, requirements and specifications, optimized design and production, tolerance assignments and cost control, and testing and checkout are discussed at length. Some examples and specification passages are cited by way of illustration. R. D. V.

**A77-46508** # Process development for fabricating sculptured decorative interior aircraft panels using sheet molding compounds. G. S. Kobayashi and E. R. Pelton (Boeing Co., Seattle, Wash.). In: Discover reinforced plastics, Proceedings of the Thirty-second Annual Conference, Washington, D. C., February 8-11, 1977. New York, Society of the Plastics Industry, Inc., 1977, p. 2-A-1 to 2-A-9.

**A77-46516** # Composite tanks for aerospace vehicle application. R. E. Landes and E. E. Morris (Structural Composites Industries, Inc., Azusa, Calif.). In: Discover reinforced plastics, Proceedings of the Thirty-second Annual Conference, Washington, D. C., February 8-11, 1977. New York, Society of the Plastics Industry, Inc., 1977, p. 11-B-1 to 11-B-10.

Pressure vessels fabricated from Kevlar/stainless steel and Kevlar/aluminum composites were subjected to fatigue cycling, sustained loading and hydrostatic burst tests to determine their suitability for use in aerospace vehicles. Six 61-cm Kevlar/cryoformed stainless steel tanks and six 97-cm Kevlar/aluminum tanks were involved in the testing. The Kevlar/stainless steel vessels, which exhibited very high pressure resistance, also provide a 25 to 30% weight saving over comparable noncomposite titanium vessels. Both the Kevlar/stainless steel and Kevlar/aluminum sphere designs demonstrated nonfragmentation and controlled-failure features, when failure was induced during pressure cycling, localized noncatastrophic leakage was observed. J. M. B.

**A77-46519** # Composite horizontal stabilizer for the B-1 - Design, fabrication and test. W. Ludwig, H. Erbacher, and G. Lubin (Grumman Corp., Bethpage, N. Y.). In: Discover reinforced plastics, Proceedings of the Thirty-second Annual Conference, Washington, D. C., February 8-11, 1977. New York, Society of the Plastics Industry, Inc., 1977, p. 15-B-1 to 15-B-9.

The composite design for the stabilizer was developed to satisfy all of the form, fit and functional requirements of the B-1 aircraft and to be competitive with the metal stabilizer on both a weight and production cost basis. Actual weights of the composite stabilizer show a 15% savings for the total stabilizer and 21% for the composite torque box over the existing metal configuration. Cost savings of 17 to 20% are estimated in production. The design that evolved from this effort, the test data generated to validate the concept, the fabrication procedures used and production cost comparisons are presented (Author)

**A77-46520** \* # Composite hubs for low cost turbine engines. C. C. Chamis (NASA, Lewis Research Center, Cleveland, Ohio). In: Discover reinforced plastics, Proceedings of the Thirty-second Annual Conference, Washington, D. C., February 8-11, 1977. New York, Society of the Plastics Industry, Inc., 1977, p. 15-C-1 to 15-C-7. 5 refs.

A detailed stress analysis is performed using NASTRAN to demonstrate theoretically the adequacy of composite hubs for low cost turbine engine applications. The results show that composite hubs are adequate for this application from the steady state stress viewpoint (Author)

**A77-46575** F-18 blends advanced fighter concepts. D. E. Fink. *Aviation Week and Space Technology*, vol. 107, Sept. 5, 1977, p. 38-41, 43.

The article presents the advanced concepts being developed for the F-18 Hornet fighter aircraft for use by the Navy and Marine Corps. A comparison is made between the F-18 and the YF-17, highlighting those characteristics of the F-18 which make it particularly suitable for carriers. Descriptions of several other features of the F-18 are discussed including the accessibility of the cannon and ammunition drum, the possibility of quick engine changes, and the F404 twin turbojet engines. The fuel system is described in terms of its basic operation, aerial refueling, and the materials of its construction. The flight control system is fully discussed including a description of the cockpit layout, computer system, and safety devices. S. C. S.

**A77-46606** # The arrow wing - Its potentialities and drawbacks with regard to in-flight aerodynamic research. J. E. Chacksfield (British Aircraft Corp., Ltd., Military Aircraft Div., Warton Aerodrome, Lancs., England). *Aircraft Engineering*, vol. 49, Aug. 1977, p. 4-8.

A description of the features involved in a new integrated design for the optimization of the arrow wing planform is presented. These modifications include the revision of the shape of the pure wing, and aerodynamic features such as L/D optimization, the addition of LE flaps and the attainment of near-scale Reynolds numbers for the wing section, planform variations, the nacelle location, wing-nacelle interference, and wing-fuselage interaction. The features of this new

design which are dependent on the aircraft's overall structure are reviewed. A list of the factors requiring comprehensive subsonic and supersonic in flight research is included. SCS

**A77-46614 \* # Computational methods to obtain time optimal jet engine control** R J Basso and R J Leake (Notre Dame, University, Notre Dame, Ind.) In Annual Allerton Conference on Circuit and System Theory, 14th, Monticello, Ill, September 29-October 1, 1976, Proceedings. Urbana, Ill., University of Illinois, 1976, p 652-661 10 refs Grant No NsG-3048

Dynamic Programming and the Fletcher-Reeves Conjugate Gradient Method are two existing methods which can be applied to solve a general class of unconstrained fixed time, free right end optimal control problems. New techniques are developed to adapt these methods to solve a time optimal control problem with state variable and control constraints. Specifically, they are applied to compute a time optimal control for a jet engine control problem.

(Author)

**A77-46617 # Singular perturbation analysis approach for systems with highly coupled dynamics.** A J Calise (Dynamics Research Corp., Wilmington, Mass.) In Annual Allerton Conference on Circuit and System Theory, 14th, Monticello, Ill, September 29-October 1, 1976, Proceedings. Urbana, Ill., University of Illinois, 1976, p. 793-806 15 refs

This paper proposes a procedure for applying singular perturbation methods to separately analyze state dynamics even when they are highly coupled. The intent is to expand the family of problems to which these methods can be successfully applied. In particular several problems in flight mechanics are identified. Numerical results for the minimum time to climb problem are given where the procedure is used to separate altitude and flight path angle dynamics to produce a closed-form solution for lift.

(Author)

**A77-46618 \* # Characteristics of the boundary-layer equations of the minimum time-to-climb problem** M D Ardema (NASA, Ames Research Center, Moffett Field, Calif.) In Annual Allerton Conference on Circuit and System Theory, 14th, Monticello, Ill, September 29-October 1, 1976, Proceedings. Urbana, Ill., University of Illinois, 1976, p 807-817 7 refs

In many singular perturbation solutions of optimal control problems, the most difficult numerical task is to solve the boundary-layer equations. However, these equations have a special structure that may often be used to expedite their solution. This paper begins by noting the general nature of the boundary-layer equations for optimal control problems. These results are then applied to the aircraft minimum time-to-climb problem. A specific numerical example is considered to illustrate the characteristics of the solution of the boundary-layer equations for this problem.

(Author)

**A77-46621 \* # Linear regulator design for stochastic systems by a multiple time scales method** D Teneketzis and N R Sandell, Jr (MIT, Cambridge, Mass.) In Annual Allerton Conference on Circuit and System Theory, 14th, Monticello, Ill, September 29-October 1, 1976, Proceedings. Urbana, Ill., University of Illinois, 1976, p 860-874 32 refs. Grant No NGL-22-009-124, Contract No E(49-18)-2087

This paper develops a hierarchically-structured, suboptimal controller for a linear stochastic system composed of fast and slow subsystems. It is proved that the controller is optimal in the limit as the separation of time scales of the subsystems becomes infinite. The methodology is illustrated by design of a controller to suppress the phugoid and short period modes of the longitudinal dynamics of the F-8 aircraft.

(Author)

**A77-46630 Satellite communications for the mobile service** W Luksch (ESA, Paris, France) In New themes for space. Mankind's future needs and aspirations, Proceedings of the Bicentennial Space Symposium, Washington, D C, October 6-8, 1976.

San Diego, Calif., American Astronautical Society, 1977, p 45-58 (AAS 76-045)

The paper discusses the current and future use of satellites for the mobile communications service. Starting with the current satellites produced for the maritime and aeronautical services (with particular reference to the two programs in which the European Space Agency is involved - Marots and Aerosat), the paper proceeds to discuss possible future growth in this field and analysis near-term developments in maritime and aeronautical communications, including the prospects for a possible integration of the two services. The sparingly studied subject of the use of satellites for land mobile applications is analyzed with attention to institutional and regulatory problems which may be anticipated. The paper concludes with an overview analysis of the future of all types of satellite communication service to mobile platforms.

(Author)

**A77-46801 # A-7 titanium nose gear development** S H Yarbrough (Vought Corp., Dallas, Tex.) *Society for Experimental Stress Analysis, Spring Meeting, Dallas, Tex., May 15-20, 1977, Paper. 23 p*

An investigation of the A-7 aircraft nose gear failures, together with a history of galvanic corrosion on the wear surfaces and stress corrosion cracks in the housing forging plane led to a program for the redesign and testing of the nose gear shock strut components, substituting titanium for previously used critical aluminum housings. The original design and testing of the nose landing gear assembly is reviewed along with its service history. The redesign trade study and several tests are described including the wear test program, static and fatigue tests, second fatigue and wear tests, the first drop test series, carrier suitability tests, test bearing pressures, and flight testing. It is concluded that the A-7 titanium gear has proven an effective substitute for the original aluminum gear, and that its increased cost and weight are justified.

SCS

**A77-46805 # Flutter-suppression studies on an actively controlled variable-geometry wind-tunnel model.** R Stearman, J Long (Texas, University, Austin, Tex.), and L Lehman (Stanford University, Stanford, Calif.) *Society for Experimental Stress Analysis, Spring Meeting, Dallas, Tex., May 15-20, 1977, Paper. 46 p* 7 refs USAF-supported research

Active flutter suppression design concepts proposed for a variable-geometry aircraft were studied for cases in which a serious degradation in flutter margin occurs when the wing of the aircraft is swept into the vicinity of the tail. An effective flutter suppression mechanism was first identified on a simple low-cost semirigid wind-tunnel flutter model of this configuration. The preliminary studies led to the design and wind tunnel testing of a more sophisticated aeroelastic flutter model of this basic geometry. Experiments on the more sophisticated model confirmed that flutter margins could be significantly improved by employing rapidly-responding aerodynamic controls activated by optimal feedback.

(Author)

**A77-46807 # Aircraft composite primary structures in Brazil** H W Smith (Kansas, University, Lawrence, Kan.) *Society for Experimental Stress Analysis, Spring Meeting, Dallas, Tex., May 15-20, 1977, Paper. 17 p* 12 refs

A variety of glass fiber and resin combinations were used to make tension and fatigue specimens. A trapezoidal component was also manufactured, instrumented and tested. Foil type strain gages and dial gages were used as primary sensors. Load cells were also used. The component was a hollow trapezoidal cantilever, rigidly supported at the root and loaded at the free end. Data is reported for the pure flexure and pure torsion tests, and for the destruction test in bending. Specimens cut from the broken component were tested in tension and compression. Derived values of strength and modulus of elasticity are reported. Unidirectionally reinforced specimens had the highest values of stress and modulus (2800 kg/sq cm and 160,000 kg/sq cm) and the random mat composites had the lowest values (941 kg/sq cm and 91,000 kg/sq cm).

(Author)

**A77-46808 # Durability testing of the A-7D composite outer-wing panel** E G Smith, J H Pimm, and J F Mall (Vought Corp, Dallas, Tex) *Society for Experimental Stress Analysis, Spring Meeting, Dallas, Tex, May 15-20, 1977, Paper 29 p*

The purpose of the reported test program was to increase confidence in the use of composite material and to qualify the outer panel for unrestricted flight. The outer-wing tested consists of a structurally complete left-hand outer panel. The outer wing panel has a span of 96 inches. The main wing box structure of the outer panel is constructed of advanced composite materials. Attention is given to a description of the test article, the test plan, the durability (fatigue) test, environmental conditioning, fatigue cycling, an elevated temperature fatigue test, and a residual strength test. G R

**A77-46825 # Investigation of landing gear deck obstruction effects by drop testing** J E Evans (Vought Corp, Dallas, Tex) *Society for Experimental Stress Analysis, Spring Meeting, Dallas, Tex, May 15-20, 1977, Paper 9 p*

A unique drop test facility has been designed to simulate the carrier deck environment during high speed landings of carrier-based aircraft. This paper reviews the criteria used in the Navy S-3A landing gear design and discusses laboratory tests conducted to determine the deck obstruction effects on landing gear loads. Data gathered during subsequent flight testing at NATC, Maryland, is compared with that obtained in the laboratory. (Author)

**A77-46838 # Accelerated environmental conditioning of the A-7D composite outer wing** G Bourland (Vought Corp, Dallas, Tex) *Society for Experimental Stress Analysis, Spring Meeting, Dallas, Tex, May 15-20, 1977, Paper 13 p* Contract No F33615-73-C-5066

The environmental conditioning used to simulate long-term moisture and temperature effects on an advanced-composite outer-wing assembly for the A-7D aircraft is described. Structural features of the outwing assembly, which consists primarily of a graphite/epoxy substructure and a graphite/boron/epoxy hybrid skin, are discussed, estimates of the seven-year moisture absorption in laminates of various thicknesses are determined on the basis of 35-day conditioning at a temperature of 150 F and 100% relative humidity. Fatigue and residual strength tests performed after the environmental conditioning are used to assess the operational durability of the assembly over seven years of land-based service. J M B

**A77-46848 # Variable geometry air cycle machine** J Tseka (United Technologies Corp, Hamilton Standard Div, Windsor Locks, Conn) and G C Letton, Jr (USAF, Aeronautical Systems Div, Wright-Patterson AFB, Ohio) *ASME, SAE, AIAA, ASMA, and AIChE, Intersociety Conference on Environmental Systems, 7th, San Francisco, Calif, July 11-14, 1977, ASME Paper 77-ENAS-7. 9 p* Members, \$1 50, nonmembers, \$3 00

There is a continuing need to develop environmental control system (ECS) concepts which give increased performance or reduce aircraft penalties. Use of a variable-geometry air cycle machine is one approach for achieving improved ECS performance over a wide range of operational conditions with less overall aircraft penalty. A program to develop an Advanced Environmental Control System (AECS) has resulted in the development of a variable-geometry bootstrap air cycle machine which includes both a variable-geometry turbine nozzle and compressor diffuser. The reasons for selecting a variable-geometry air cycle machine and its impact on AECS weight and engine bleed air consumption are discussed. This paper shows how single-acting movable turbine nozzle and compressor diffuser vanes were implemented in the bootstrap air cycle machine to achieve desired efficiencies over flow ranges of 4:1, which is twice that achievable by existing state-of-the-art air cycle machines. The variable-geometry air cycle machine underwent a flight-worthiness test program. Included are discussions on performance levels achieved and mechanical acceptability of the design. (Author)

**A77-46849 # A comparison of ECS controls** G T Puhl (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *ASME, SAE, AIAA, ASMA, and AIChE, Intersociety Conference on Environmental Systems, 7th, San Francisco, Calif, July 11-14, 1977, ASME Paper 77-ENAS-8. 20 p* 12 refs. Members, \$1 50, nonmembers, \$3 00

The study presented in this paper consists of a comparison of the conventional control implementation, fluidic control implementation developed under contract by the AFFDL, and hypothetical digital electronic control implementations in non-redundant and dual-redundant configurations for an F-4 Aircraft Cabin-Air Conditioning System. The Cabin-Air Conditioning System of the F-4 Aircraft was selected as the baseline system due to the availability of data for this system and the contractually developed fluidic control implementation for a comparable system. The digital electronic control model of this study was assumed to employ sensors and actuators in an identical manner to the fluidic control implementation for the purpose of providing a direct comparison. The different control implementations are compared on the basis of performance, control reliability, relative production and maintenance costs, and survivability and adaptability. (Author)

**A77-46851 # A rotating high pressure water condenser and separator** J W Crawford (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *ASME, SAE, AIAA, ASMA, and AIChE, Intersociety Conference on Environmental Systems, 7th, San Francisco, Calif, July 11-14, 1977, ASME Paper 77-ENAS-10. 14 p.* 5 refs. Members, \$1 50, nonmembers, \$3 00. Contract No F33615-74-C-3039

A new concept has been developed to remove water from the bleed air stream of an aircraft Advanced Environmental Control System (AECS). The new concept is a rotating high pressure condenser and water separator. The water separator is rotated by an electric motor to provide a radial centrifugal force on the condensed water droplets to move them to a collection volume where they are expelled. The rotation also provides a uniform fin matrix temperature by causing periodic movement of the matrix between the cold side inlet and outlet. Finally, rotation provides self-cleaning of any snow particles that come from the upstream turbine by reversing the flow direction over the matrix each revolution. Design rationale, performance test results as a component and as part of the system and component structural and environmental qualification test results will be presented. An overview of the AECS including the function of the water separator in the system will be presented. (Author)

**A77-46904 # Design-to-cost in action** R L Bidwell (US Department of Defense, Product Engineering Services Office, Alexandria, Va) *American Society of Mechanical Engineers, Design Engineering Conference and Show, Chicago, Ill, May 9-12, 1977, Paper 77-DE-9. 8 p* Members, \$1 50, nonmembers, \$3 00

The design-to-cost management philosophy instituted by the US Department of Defense to analyze and control cost overruns incurred by contractors is discussed. Case histories involving successes and failures in obtaining adequate product cost estimates from defense contractors and subcontractors during the design phase are given, and a detailed set of criteria for evaluating the acceptability of a contractor's design-to-cost program is provided. Emphasis is placed on identifying and controlling the most costly elements in a design, incorporating production and support costs into design-phase estimates and expressing costs in terms of man-hours of production and material costs. J M B

**A77-46915 # Fatigue life prediction of complex structures** B N Leis (Battelle Columbus Laboratories, Columbus, Ohio) *American Society of Mechanical Engineers, Design Engineering Conference and Show, Chicago, Ill, May 9-12, 1977, Paper 77-DE-46. 8 p* 52 refs. Members, \$1 50, nonmembers, \$3 00. USAF-sponsored research

Analytical procedures for predicting finite-fatigue life for simple notched coupons are reviewed. One problem in adapting these

procedures to making life predictions for complex components and structures is that of the multiplicity of crack initiation sites and mechanisms which determine the fatigue life of such structures. It has been observed that the service environment and the magnitude and character of the service loading are responsible for determining which of the many potential initiation sites and mechanisms control failures. This paper examines available technology for fatigue analysis of complex structures in which the multiplicity of initiation sites and mechanisms control the life of the structure. It was concluded that those techniques most likely to yield accurate predictions were based on the critical location concept. Complexities in the use of this concept in fatigue analysis are defined and the concept is illustrated by application to the fatigue analysis of a component configuration which simulates a joint in an airframe. Finally, the use of the critical location concept as an aid to understanding the mechanisms of fatigue improvement fasteners is discussed. (Author)

**A77-46975**      **The Mirage-2000 (Le Mirage 2000)** J. Morriset *Air et Cosmos*, vol 15, May 21, 1977, p 27-29, 31, 33. In French

The Mirage-2000, scheduled for test flight in October, 1978, is described. Choice of the delta wing configuration and the aerodynamic analyses and design programs leading to development of the aircraft are reviewed, the hydraulic servocommand system, radar, autopilot and data processing system chosen for the plane are also considered. Use of boron and carbon-fiber composites to reduce weight and retractable wing components to provide versatile performance is discussed. The propulsion system, which renders the Mirage 2000 capable of high-altitude flight at speeds of Mach 2.3 to 2.5, is described. Data on acceleration, payload and fuel capacity, range and operational altitude ceiling of the aircraft are also given. In addition, aspects of the landing gear, including the graphite hybrid brakes and electrohydraulic controls, are mentioned. J M B

**A77-46984 #**      **Increasing jet-engine thrust by water-augmentation (Povyshenie tiagi vozdušno-reaktivnogo dvigatelia putem ballastirovaniia strui zabortnoi vody)** I M Chernyi and A I Kravtseva (Akademiia Nauk Ukrainskoi SSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR) *Gidromekhanika*, no 36, 1977, p 41-46. 5 refs. In Russian

The feasibility of using water-augmented air jets for the propulsion of high-speed vessels is analyzed. A solution is obtained with allowance for losses in the inlet main and atomizer, for the resistance of the water intake mechanism, and for the mixing losses in the nozzle. The gain resulting from water-augmentation is computed. V P

**A77-47005**      **Upstream influence on the near field of a plane turbulent jet** A K M F Hussain and A R Clark (Houston, University, Houston, Tex.) *Physics of Fluids*, vol 20, Sept 1977, p 1416-1426. 47 refs. NSF Grant No GK-32626, Contract No N00014-68-A-0402-0008

Experiments investigating the effects of the mean and turbulence characteristics of the upstream boundary layer on the evolution of the flow in the near field of a plane jet for four initial conditions are described. The study was carried out for two asymptotic initial mean velocity profiles, i.e., the laminar 'top-hat' profile and the fully developed turbulent profile. For the latter case, the flow is vortical, while for the initially laminar cases, two free shear layers of opposite vorticity grow separately and merge downstream. The growth rate of longitudinal turbulence intensity and the mass flux are higher when the initial boundary layer is laminar than when turbulent. B J

**A77-47090 #**      **An optical technique for measuring vibratory motion in rotating machinery** F Bien and M Camac (Aerodyne Research, Inc., Bedford, Mass.) *AIAA Journal*, vol 15, Sept. 1977, p 1257-1260. 7 refs. Research sponsored by the Aerodyne Research, Inc.

A method to measure the frequency and amplitude of vibration in a rotating element is presented. Using optical interferometric

techniques, the flexure and torsion of a gas turbine compressor blade is shown to be measurable over the entire 360 deg of rotation. Vibrations are shown to be measurable independent of blade rotation speed, the effects of misalignment in system are shown to be small. Angular deflections from 0.5 to 500 mrad were measured in the test system. (Author)

**A77-47108 \* #**      **Flow characteristics in an expansion tunnel as inferred from velocity measurements** C G Miller and W J Friesen (NASA, Langley Research Center, Space Systems Div., Hampton, Va.) *AIAA Journal*, vol 15, Sept 1977, p 1364-1366. 6 refs.

A photoionization technique was used to study flow characteristics in an expansion tunnel. Vertical surveys of the axial component of flow velocity just downstream from the nozzle exit were obtained, and estimates of freestream density were inferred from the velocity measurement technique. The pitot pressure was measured and compared to the average axial component of velocity as a function of time for the two cases when air and CO<sub>2</sub> were used as test gases. Vertical velocity and static density profiles at the nozzle exit are presented for the case when CO<sub>2</sub> was used as test gas. Experimental results were used to determine the diameter and uniformity of the test core at the nozzle exit and the duration of the quasi-steady flow period. These data are relevant to evaluation of the suitability of operating an expansion tube as an expansion tunnel. The expansion tunnel is an expansion tube with a conical nozzle positioned at the exit of the acceleration section, so that nozzle entrance flow conditions are hypersonic and characterized by hypervelocity. M L

**A77-47136**      **Thermal stability of transition metal monocarbide fibers in refractory composites prepared by unidirectional solidification (Stabilité thermique des fibres de monocarbures de métaux de transition dans les composites réfractaires élaborés par solidification unidirectionnelle)** J F Stohr, T Khan, M Rabinovitch, and H Bibring (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) In *International Conference on the Strength of Metals and Alloys*, 4th, Nancy, France, August 30-September 3, 1976, Proceedings Volume 2. Nancy, Ecole Nationale Supérieure de la Metallurgie et de l'Industrie des Mines, 1976, p 569-573. 13 refs. In French

The thermal stability of Cotac composites was studied with the intention of determining their suitability for aircraft turbines. Cotac alloys consist mainly of Co, Ni, Cr, and also of a transition metal carbide. Composite stability during thermal cycling and Cotac composite stability in the presence of a thermal gradient normal to the fibers were determined. Fiber degradation during thermal cycling plays a major role in the plastic deformation of the matrix, and, by increasing the resistance to plastic flow of the matrix, it was possible to develop two new composites which are practically unaffected by thermal cycling to 1100 C. The Cotac composites were basically unaffected by thermal gradients perpendicular to the fibers of 100 C/mm up to 1100 C. M L

**A77-47199 #**      **Aircraft laboratories and experience in using them for the development of methods and means of remote sensing of earth resources (Samoletnye laboratorii i opyt ikh ispol'zovaniia pri obrabotke metodov i sredstv distantsionnykh issledovaniia zemnykh resursov)** Ia L Ziman, M Iu Sazhko, and V S Tsitovich. In *Space studies of earth resources. Methods and means of measurement and data processing*. Moscow, Izdatel'stvo Nauka, 1976, p 275-280. In Russian

**A77-47200 #**      **Space experiment simulation using an aircraft laboratory (Modelirovanie kosmicheskogo eksperimenta s pomoshch'iu samoletnoi laboratorii)** G A Avanesov, I V Barinov, V D Glazkov, Ia L Ziman, and V I Tarnopol'skii. In *Space studies of earth resources. Methods and means of measurement and data processing*. Moscow, Izdatel'stvo Nauka, 1976, p 280-290. 6 refs. In Russian

A two-year program devoted to the airborne simulation of procedures of satellite remote sensing of earth resources is reviewed. The structure of the airborne system is described with attention given to remote sensors, preliminary and thematic processing equipment, and recording instruments. A functional diagram of the airborne system is presented and an optical system for the multispectral scanning system and a system for separating radiative fluxes are considered. Use of simulation data in elaborating ground-based means of data processing and interpretation is discussed. B J

**A77-47248**      **Aerodynamics of a confined jet with variable density** F R Steward and A G Guruz (New Brunswick, University, Fredericton, Canada) *Combustion Science and Technology*, vol 16, no 1-2, 1977, p 29-45 12 refs National Research Council of Canada Grant No A-1942

A similarity parameter has been obtained for a confined turbulent jet system of constant cross section for which the nozzle fluid and the surrounding fluid have different densities. This parameter was derived from the time smoothed equations of motion with certain simplifying assumptions. Velocity, temperature and tracer concentration profiles were measured on such a system with the similarity parameter, called the nonisothermal Craya-Curtet number, varied over a range of 0.22 to 1.2. The experimental data were correlated with the similarity parameter in a manner which supports its validity. (Author)

**A77-47257**      **The development and simulation of an automatic gunnery system for advanced fighter aircraft** W P Summers, G J Komechak, and W S Bennett (General Dynamics Corp., Fort Worth, Tex.) In *Annual Simulation Symposium*, 10th, Tampa, Fla., March 16-18, 1977, Record of Proceedings Tampa, Fla., Annual Simulation Symposium, Long Beach, Calif., IEEE Computer Society, 1977, p 385-399

A predominant error source in modern airborne gunnery systems is the inability of the pilot to track a target under highly dynamic conditions. A search for methods and techniques for improving aerial gunnery led to two approaches for improving gunnery effectiveness. The first approach, the coupling of the fire control system with the aircraft's flight control system to provide automatic tracking of the target, and the second approach, a trainable gun mechanization were evaluated by simulation, and the results are presented in this paper. On the basis of results, significant improvement in effectiveness can be achieved in comparison to the manual tracking method used in modern fighters. (Author)

**A77-47271** #      **The military utility of very large airplanes and alternative fuels** W T Mikolowsky (Rand Corp., Washington, D C), L W Noggle (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio), and W L Stanley (Rand Corp., Santa Monica, Calif.) *Astronautics and Aeronautics*, vol 15, Sept 1977, p 46-56 21 refs

The paper describes a study with the objectives of evaluating very large airplanes (VLA's) in the context of existing and possible future Air Force missions and determining the most attractive alternative fuel for these airplanes. The chemical fuel alternatives considered are liquid hydrogen, liquid methane, and synthetic JP, each of which can be readily synthesized from coal. The nuclear-fueled VLA was a fourth candidate aircraft. The cost and energy effectiveness of these basic aircraft-fuel combinations in typical range, radius, and station-keeping missions was estimated. It was concluded that overall, a conventional hydrocarbon jet fuel remains the most attractive fuel for military aircraft. Nuclear propulsion is attractive only for station-keeping missions requiring large station radius. VLA's are especially attractive if the capability to airlift US forces world-wide without reliance on overseas bases is a major requirement. P T H

**A77-47333**      **The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977.** Symposium sponsored by the National Association

for Remotely Piloted Vehicles, Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977 182 p \$25

Attention is given to complementary roles for RPVs in support of tactical manned aircraft, an operational concept for a battlefield surveillance RPV system (Canadair CL-227), RPV applications of the Tomahawk cruise missile, and the Aquila mini-RPV program. The selection of optimum RPV operational launch and recovery techniques, tethered hover flight tests of a vertical attitude takeoff and landing RPV, the development of an ultra-low-cost gas turbine for RPV applications, and the development of the Multiple Drone Control System are also considered. B J

**A77-47334** #      **Complementary roles for RPVs in support of tactical manned aircraft** C A Zraket and S E Rose (Mitre Corp., Bedford, Mass.) In *The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977* Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 1-7

As a result of new technology in computer, sensor and communications electronics, it is feasible for the crew of tactical strike aircraft to control a supporting force of 'smart' RPVs which are able to operate semi-autonomously in a number of missions without continual remote control. The RPVs have the inherent capability to electronically sense the threat environment, take self-initiated evasive maneuvers and transmit this data to other RPVs and the manned aircraft. By providing this information to the data-processing capability distributed among the aircraft, the RPVs and ground tactical control centers, it will be feasible, in real time, to reconfigure the overall attack against the most recently perceived threat. The use of RPVs in support of tactical manned aircraft promises to significantly reduce the cost and to increase the size and effectiveness of the total fleet. (Author)

**A77-47335** #      **Operational concept for a battlefield surveillance RPV system /Canadair CL-227/** J P Kezr (Canadair, Ltd., Montreal, Canada) In *The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977* Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 8-12

An operational concept is described for a battlefield surveillance RPV system designed to provide field commanders with an organic capability for real-time surveillance over enemy terrain, immediate acquisition of targets and fire adjustment-target designation. The RPV system comprises Control Stations, RPV Stations and RPV's with Payloads, it is the Canadair CL-227 system. The systems characteristics provide the basis for an operational concept whereby RPV preparation, take-off, landing and servicing is undertaken well to the rear while control during a mission is exercised by a forward station. The phases of such an operation are described together with a maintenance concept. (Author)

**A77-47336** #      **RPV applications of Tomahawk cruise missile** R A Lynch, J D Sutcliffe, L E Murphy, Jr., and W R Karmazin (General Dynamics Corp., Convair Div., San Diego, Calif.) In *The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977*

Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 13-18

The versatility and durability of the Tomahawk cruise missile incorporated into an RPV system are recommended. Originally designed for submarine launch, the Tomahawk in its RPV format can be launched from ground, vehicles, shipboard, or aircraft, with a quick-disconnect 1000-lb payload and a range of 1500 nautical miles. Recoverability and prompt reusability are additional advantages of the weapon system. Reconnaissance, jamming and chaffing nuisance missions, and strikes against hard targets and sheltered or revetted aircraft are possible applications. R D V

**A77-47337** #      **Tactical expendable drone system /TEDS/** O H Caperton (Northrop Corp., Ventura Div., Newbury Park, Calif.) In *The RPV - Complement to manned systems, Proceedings of the*



Fourth Annual Symposium, Washington, D C, June 5-9, 1977  
Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 19-23

Tactical combat uses of TEDs (tactical expendable drones) in strike and support missions are outlined, and results of validation and flight tests are presented. Decoy service against hostile AAA and/or SAM, deployment as a diversionary decoy strike force, penetration aid as area-distributed jammer, and target acquisition support applications are described. Saturation and dilution of hostile defense systems are emphasized. Production, storage, maintenance, combat deployment, and launches of TEDs are outlined. R D V

**A77-47338 #** The development of the XMQM-105 Aquila mini-RPV system. F D Schnebly (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 24-32.

The Army's Aquila program began in January 1975 with the objective of demonstrating the application of mini-RPV technology to missions of surveillance, artillery fire adjustment and laser designation. This paper reviews major events during the course of the program with emphasis on technical, scheduling and programmatic aspects. Particular emphasis is placed on the system aspects of mini-RPVs and innovative test approaches. Film and video highlights of launch and recovery operations are shown along with imaging data from onboard sensors. B J

**A77-47339 #** U S / F R G. advanced tactical RPV requirements as analyzed by Boeing and Dornier. D J O'Brian, P H Schweizer (Boeing Co., Seattle, Wash.), and J Spintzyk (Dornier GmbH, Friedrichshafen, West Germany). In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 33-40.

Tactical combat requirements for effective use of remote piloted vehicles (RPV) are assessed for a central European scenario. Reliance on RPVs is found best advised when combat attrition rates are high and a certain range of fixed or transient targets are to be engaged, mixes of RPVs and manned aircraft are considered. Alert capability, survivability on the ground, 24-hr all-weather capability, and RPV use as escorts and precursors are highlighted. Recommended recon missions include detailed zone reconnaissance of concentrated armor, area activity sampling along communication routes, and bomb damage assessment after strikes. Low cost, modest personnel requirements, and saving of trained personnel for other tasks are emphasized. R D V

**A77-47340 #** Selection of optimum RPV operational launch and recovery techniques. W J Potocki (Rockwell International Corp., Missile Systems Div., Columbus, Ohio). In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 41-49.

A qualitative study of production, technology, and cost control problems in working out optimum launch and recovery techniques for combat RPVs (remotely piloted vehicles) is presented. Cost/benefit/risk analysis and life cycle cost analysis studies are described. Candidate systems and hardware for RPV launch and recovery operations are listed and compared. The study is recommended as an attack on problems not amenable to detailed quantitative procedures, while offering reasonably rapid convergence to the most appropriate candidates to be given closer attention in system development. R D V

**A77-47341 #** Tethered hover flight tests of a vertical attitude takeoff and landing remotely piloted vehicle. W H Eilertson (U S Naval Material Command, David W Taylor Naval Ship Research and Development Center, Bethesda, Md.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual

Symposium, Washington, D C, June 5-9, 1977

Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 50-58. 6 refs

Vertical attitude takeoff and landing offers attractive advantages to the Navy in that ship interface problems are alleviated. A 560-lb demonstration vehicle was designed to assess these advantages. This vehicle will be flight tested to assess vertical hover capability in the turbulent aerodynamic wake generated by a ship's superstructure while underway. The design incorporates a close coupled canard/delta wing configuration. Components from the Harpoon missile are utilized. Tethered flight tests in hover were recently demonstrated successfully. (Author)

**A77-47342 #** The mini-RPV, cost effectiveness in a tactical environment. E A Rose, Jr and J H Budiansky (E-Systems, Inc., Falls Church, Va.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 59-65.

A cost effectiveness analysis to examine RPV deployment in defense suppression, 'loiter mine' and jamming is described. Scenarios are used to develop rationale for cost effectiveness tradeoffs that demonstrate aid to manned systems in the battlefield. Mission profiles in hypothetical but reasonable European scenarios are used as a background for the analysis. Examples of low cost component technology and manufacturing techniques being used to develop operational systems, and representative RPV hardware, are included. (Author)

**A77-47343 #** Synergistic growth of ITCS to a tactical RPV C2 system. D Barrow (Motorola, Inc., Government Electronics Div., Scottsdale, Ariz.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 66-70. Navy-supported research.

This paper presents a brief technical overview and summary of test results on the Integrated Target Control System (ITCS) developed by Motorola under contract to Naval Air Systems Command. A wideband anti-jam data link developed under a Motorola Independent Research and Development program is also discussed. ITCS was developed as a set of control stations operating at ranges to 250 nautical miles and associated target avionics. It is the most modern, operational, integrated system in existence today for command, control, and tracking of unpiloted vehicles. The technology and hands-on experience gained from the ITCS program are directly applicable to tactical RPV command, control, and information transfer problem. The proven hardware and operational experience gained from ITCS coupled with demonstrated hardware and state-of-the-art technology from the Motorola anti-jam wideband data link provide the basis for an advanced design, high performance, cost effective RPV command, control, and information transfer system. (Author)

**A77-47344 #** Development of an ultra-low-cost gas turbine. C F Baerst and W M Norgren (AiResearch Manufacturing Company of Arizona, Phoenix, Ariz.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C, June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 71-78. USAF-supported research.

By utilizing the aerodynamic components from a high-production, low-cost truck engine turbocharger, a new generation of ultra-low-cost turbine engines is developed. A series of engines in the 100- to 200-pound thrust class, under development by Garrett/AiResearch, is presented. One engine is a simple conversion of the Model T-18A turbocharger to an engine with 100-pounds thrust. A second version redesigns the turbine and adds a sudden expansion burner for augmentation and produces about 200-pounds thrust. Both engines were fabricated and successfully run in sea level thrust stands. Testing of these prototypes proved the performance capability.

ty of this concept and provided the basis for future engine development (Author)

**A77-47345 # Multiple Drone Control development** R E Winkler (Sperry Rand Corp., Sperry Univac Div., Salt Lake City, Utah) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 79-84

This paper discusses the development of the Multiple Drone Control (MDC) System and its application in the use of multiple RPVs for operational EW missions. The system evolution from one-on-one control, using the AN/UPQ-3 Microwave Command Guidance System (MCGS), to the Multiple Drone Control/Strike System (MDC/SS) is described. MDC/SS, currently completing DT&E and IOT&E flight testing, is discussed, including flight test results and operational capabilities. Other potential applications of the current configuration are noted and possible future evolution of the system is discussed (Author)

**A77-47346 # An alternate recovery system for the Aquila** G R Seemann, K L Phillips, G L Harris, H E Krachman, J Hertenstein, and G Brown (Developmental Sciences, Inc., City of Industry, Calif.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 85-88 Grant No DAAJ02-76-C-0039

A soft-landing variant recovery system for the Aquila mini-RPV is described. A hydraulic drag brake arrangement is employed for test horizontal deceleration and an air mattress to facilitate vertical deceleration. The arrangements can be set up within 2 hr and dismantled within 2 hr. The RPV can be hauled to launch site and from recovery site in a pickup truck. R D V

**A77-47347 # Development of a small, low cost turbojet engine with thrust augmentation** W C Elrod, H E Wright, B L Wolfe, Jr., J D Durniak (USAF, Institute of Technology, Wright-Patterson AFB, Ohio), and D B Wilkinson (USAF, Aero-Propulsion Laboratory, Wright-Patterson AFB, Ohio) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 89-95 7 refs

Turbosuperchargers from two manufacturers were successfully converted to turbojet engines, with engine run up from idle to maximum thrust while limiting the turbine inlet temperature to 1250 K. The smaller of the two turbosupercharge systems selected for conversion (designated J-1 and J-3 engines) was the first to be converted to a turbojet engine (the J-1 unit) and subsequently the conventional combustor was replaced with a catalytic reactor (then designated the J-3 unit). The J-3 engine weighed 13.15 kg (29 lb-m) excluding the oil system and produced 133N (30 lb-f) thrust with a turbine inlet temperature of 1250 K while operating on hydrogen as a fuel. The larger turbosupercharger designated the J-2 unit operating with JP-4 as a fuel and limiting the turbine inlet temperature to 1250 K produced 330 N (74.5 lb-f) thrust dry and 483 N (109 lb-f) with afterburner. The thrust specific fuel consumption ranged from 2.2 to 3.6 (Author)

**A77-47348 # Microcomputer RPV stabilization and control system** R C Eslinger (Sperry Rand Corp., Sperry Flight Systems, Phoenix, Ariz.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 96-101.

Utilization of a microcomputer in a typical mini-midi type remote piloted vehicle (RPV) system is explored, with attention given to software development. Built-in testing procedures and automatic checkout, in addition to in-flight RPV control and

stabilization, are realizable with availability of 16-bit microprocessors with high-density memories capable of functioning over the full range of military environments. Input/output signals processed by the microcomputer in the RPV system are tabulated and discussed. R D V

**A77-47349 # An evaluation of future RPV automatic navigation systems** G J Mc Keel (Rockwell International Corp., Missile Systems Div., Columbus, Ohio) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 102-108 Contract No F33657-75-C-0518

A combination of dead reckoning and position fixing systems is recommended as best suited to future navigation system requirements for remote-piloted vehicles (RPV) designed for electronic warfare, reconnaissance, or selective strike sorties. Strapdown inertial dead reckoning is given preference over the gimballed inertial variant, and position fixes can be obtained from line-of-sight, over-horizon, or correlator type (terrain contour, radiometric) systems. R D V

**A77-47350 # Advanced avionics for the Advanced Remotely Piloted Vehicle (ARPV)** J L Perry, V K Goyal, and D R Ziesig (Systems Consultants, Inc., Dayton, Ohio) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 109-116 16 refs Contract No F33615-75-D-1125

The Advanced Remotely Piloted Vehicle (ARPV) is a new Air Force weapons system intended to perform Reconnaissance (Recce), Electronic Warfare (EW), and Strike missions in support of manned tactical aircraft. A single multi-mission multipurpose ARPV design appears more cost-effective than a proliferation of different RPV designs, each tailored to a specific mission. The ARPV's hardware and software must be capable of rapid change, from mission to mission. To achieve this required flexibility while maintaining low life cycle cost, the Air Force Avionics Laboratory (AFAL) launched an investigation of the use of advanced multiplexing and microcomputer techniques to the ARPV. The results of this effort are presented, and include a proposed data bus architecture which is a logical extension of the Air Force's Digital Avionics Information System (DAIS) (Author)

**A77-47351 # A miniature rotary-wing RPV** G D Summers, E G Greene (Atlantic Research Corp., Alexandria, Va.), and D A Martin (U S Navy, Washington, D C.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 117-120

A miniature, rotary-wing, RPV, designed and built by Atlantic Research Corporation, has been shown to be stable in flight and capable of carrying various reconnaissance payloads. The experimental aircraft has flown in several test configurations. Average all-up weight, including fuel for an hour and payload, has been approximately 26 pounds. Payloads have included a television camera and broadcast transmitter, a TV camera and a fiber-optic air-to-ground link, and a motion-picture camera. The objective of the in-house project was to demonstrate system feasibility. It is envisioned that, with further system development, this type of RPV can complement manned systems in a variety of functions, both in civil and in military applications (Author)

**A77-47352 # Remote rate control for RPVs** J Hirsch (U S Naval Ocean Systems Center, San Diego, Calif.) In The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium, Washington, D C., June 5-9, 1977 Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 121-124 11 refs

The paper proposes a tactile control system which would provide the ground controller of an RPV with the sensitivity to

detect the error rate of change and enable him to be alert to a fast buildup of error. Tactile signals would be used to present rate information as an alternative to 'quickening' a visual display. The video-tactile system would use two channels of information to provide a natural and instinctive method of control. The rate information could be extracted and telemetered to a control operator as tactile stimuli. B J

**A77-47353 # Ducted-fan VTOL RPV system** R A Johnson and R D Small (General Dynamics Corp., Convair Div., San Diego, Calif.). In *The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium*, Washington, D C., June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 125-131

A ducted-fan RPV research test vehicle which is a small, four-foot duct diameter airframe that will be capable of hover and transition to forward flight has been developed. The principle features of this airframe are its ability to take off and land vertically in confined and unprepared areas and the capacity for non-pilot trained personnel to operate the vehicle simply and safely. Ground tests were conducted on the vehicle to verify the thrust and control moments statically and to demonstrate controllability and transition characteristics on a tether rig. B J

**A77-47354 # Ku-band integrated circuit receiver** E J Crescenzi, Jr., C M Krowne, and F A Marki (Watkins-Johnson Co., Palo Alto, Calif.). In *The RPV - Complement to manned systems, Proceedings of the Fourth Annual Symposium*, Washington, D C., June 5-9, 1977. Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1977, p 132-137. 6 refs. Research supported by the Watkins-Johnson Co., Grant No DAAB07-75-C-1366

A 15 GHz receiver front-end module for RPV applications has been designed and constructed using thin film microstrip technology. The complete circuit is contained in a simple 5 cu cm hermetic module. The module contains an RF filter, a single stage GaAs FET balanced amplifier, an image reject mixer, and a GaAs FET voltage tuned oscillator. A 7.1 to 7.8 dB noise figure was achieved over the 14.4 to 15.4 GHz range, including the IF amplifier contribution. B J

**A77-47472 Ways of increasing the resources /potential lives/ of gas turbine engines** P A Viter (Kazanskiy Motorostroitel'nyi Zavod, Kazan, USSR). (*Problemy Prochnosti*, vol 8, Dec 1976, p 94-96.) *Strength of Materials*, vol 8, no 12, Sept 1977, p 1472-1475. Translation

The paper discusses some of the technical decisions which enabled both the reliability and the service life of a Soviet civil transport jet engine to be increased. Thus, the principle of combined final design stages and mastery of production of the parts was followed. Special studies were carried out to obtain high fretting corrosion resistance of contact surfaces of the blade shrouding of the first stage of the low pressure compressor. Accelerated stand tests were performed. When engines were removed prematurely from service, a system of local repair was developed and introduced for further improvement of the remaining part of the service life. P T H

**A77-47501 Fatigue 1977, Proceedings of the Conference, Cambridge University, Cambridge, England, March 28-30, 1977** Conference sponsored by the Metals Society. *Metal Science*, vol 11, Aug-Sept 1977, 167 p

Several aspects of metal fatigue are discussed. Topics include fatigue problems in service, initiation and propagation of short cracks, fatigue crack propagation, and interaction effects. Experimental and theoretical studies are described, often with respect to fatigue behavior in steel or aluminum alloys. Attention is directed to the effects of notches and persistent slip bands. Fatigue problems involving aircraft structures are considered. M L

**A77-47503 Fatigue problems in service - Aircraft structures.** P J E Forsyth (Royal Aircraft Establishment, Materials Dept., Farnborough, Hants., England). (*Metals Society, Fatigue Conference, Cambridge, England, Mar 28-30, 1977*) *Metal Science*, vol 11, Aug-Sept 1977, p 293-302. 11 refs

The sources of structural fatigue loads in aircraft are described, and examples of fatigue at joints in airframe parts are discussed. The reasons for joints being fatigue-sensitive points are considered, and the effects of cladding on the fatigue strength of aluminum alloys is examined. Features of metal plates and their microstructure are characterized. Fatigue is discussed with attention to wing spar failures, riveted joints, major lug joints, fuselage and wing apertures, and fillet radii on machined parts. It is concluded that an increase in the size of small flaws or the introduction of cladding, which causes a considerable adverse effect on plain fatigue strength, hardly changes the fatigue behavior of built-up structures. By means of careful design and improved crack growth resistance, damage caused by fatigue can be reduced. M L

**A77-47537 # Application of the finite element technique combined with the collocation method to subsonic lifting surface problems** M Hashimoto, K Washizu (Tokyo University, Tokyo, Japan), and M Ikegawa (Hitachi Co., Ltd., Tokyo, Japan). In *International Symposium on Finite Element Methods in Flow Problems, 2nd, Santa Margherita Ligure, Italy, June 14-18, 1976, Preprints*. Genoa, International Centre for Computer Aided Design, 1976, p 149-158. 11 refs

In the present paper, a finite element technique combined with the collocation method is formulated to obtain numerical solutions of an integral equation which determines the airload distribution acting on a wing placed in an incompressible uniform flow. An emphasis is placed on the continuity requirement for the shape function of the airload distribution. It is shown that the accuracy of numerical results obtained by the present finite element technique is encouraging. Although examples treated in the present paper are limited, extensions of the present technique to other integral equations are straight-forward. (Author)

**A77-47539 \* # Application of finite element approach to transonic flow problems** M M Hafez, E M Murman (Flow Research, Inc., Kent, Wash.), and L C Wellford (Southern California University, Los Angeles, Calif.). In *International Symposium on Finite Element Methods in Flow Problems, 2nd, Santa Margherita Ligure, Italy, June 14-18, 1976, Preprints*. Genoa, International Centre for Computer Aided Design, 1976, p 175-187. 25 refs. Contract No NAS1-4246

A variational finite element model for transonic small disturbance calculations is described. Different strategy is adopted in subsonic and supersonic regions. Blending elements are introduced between different regions. In the supersonic region, no upstream effect is allowed. If rectangular elements with linear shape functions are used, the model is similar to Murman's finite difference operators. Higher order shape functions, non-rectangular elements and discontinuous approximation of shock waves are also discussed. (Author)

**A77-47540 # Application of finite element method for the solution of transonic flow** A Ecer and H U Akay (Middle East Technical University, Ankara, Turkey). In *International Symposium on Finite Element Methods in Flow Problems, 2nd, Santa Margherita Ligure, Italy, June 14-18, 1976, Preprints*. Genoa, International Centre for Computer Aided Design, 1976, p 191-201. 10 refs. NATO Project 823

A variational formulation for the solution of steady, inviscid transonic flow problem is presented. An iterative scheme is defined to solve the resulting nonlinear equations which are derived using the finite element method. Subsonic and supersonic flow regions are treated separately in this procedure. Stability of the procedure for each region is discussed and numerical results are presented for two airfoil configurations. (Author)

**A77-47542 \* # Analysis of transonic flow over lifting and oscillating airfoils** S T K Chan and M R Brashears (Lockheed Missiles and Space Co, Inc., Huntsville, Ala) In International Symposium on Finite Element Methods in Flow Problems, 2nd, Santa Margherita Ligure, Italy, June 14-18, 1976, Preprints

Genoa, International Centre for Computer Aided Design, 1976, p 219-230 11 refs Contract No NAS1 13786

Finite element procedures are presented for the numerical solution of transonic flow over lifting and oscillating airfoils based on small disturbance theory. The algorithm is simple and effective in handling the mixed flow problem and, for airfoil in free air, treats the entire flow domain by making use of the far field asymptotic solution. Numerical results are presented and compared with experimental data and those obtained by finite difference relaxation techniques (Author)

**A77-47543 # Mixed finite element models and dual iterative methods for transonic flow** L C Wellford, Jr (Southern California, University, Los Angeles, Calif) and M M Hafez (Flow Research, Inc., Kent, Wash) In International Symposium on Finite Element Methods in Flow Problems, 2nd, Santa Margherita Ligure, Italy, June 14-18, 1976, Preprints

Genoa, International Centre for Computer Aided Design, 1976, p 233-245 9 refs

In this paper, finite element solutions for the transonic small disturbance formulation are developed. Mixed variational principles are constructed for transonic flow. These mixed variational principles are implemented using finite element approximations. Dual iterative methods combining a direct solution step and a gradient step are constructed for solution of the resulting equation. Numerical results are presented for flow about a circular arc airfoil (Author)

**A77-47544 # Transonic flow simulation by the finite element method via optimal control** R Glowinski (Paris VI, Université, Paris, France), J Periaux (Avions Marcel Dassault-Breguet Aviation, St Cloud, Hauts-de-Seine, France), and O Pironneau (Institut de Recherche d'Informatique et d'Automatique, Rocquencourt, Yvelines, France) In International Symposium on Finite Element Methods in Flow Problems, 2nd, Santa Margherita Ligure, Italy, June 14-18, 1976, Preprints

Genoa, International Centre for Computer Aided Design, 1976, p 249-259 7 refs

In this paper we discuss a new method for solving the transonic equations for compressible potential flow. We construct several optimal control problems of distributed parameter systems which have for solution the solution of the transonic equation. These optimal control problems are discretized by the finite element method and solved by the conjugate gradient algorithm. Thus we obtain a new class of methods which converge also for flows with shocks and which is well adapted to two or three dimensional flows around multi-bodies airfoils (Author)

**A77-47561 Problems in predicting aircraft noise exposure** A H Odell (Port Authority of New York and New Jersey, New York, N.Y.) *Noise Control Engineering*, vol 9, July-Aug 1977, p 32-37 21 refs

A theory is proposed to calculate aircraft noise exposure in terms of the subjective reaction of the exposed population by evaluating the combination of aircraft noise along with psychological factors such as the time of day, season, background noise, etc. Critical areas in noise exposure calculation are identified including the plotting of turns after takeoff and the variability of noise levels from aircraft at a fixed point. Suggestions are made for improving the degree of technical accuracy in calculating noise levels, such as (1) a statistical study of actual noise levels produced by each type of aircraft as function of stage length, (2) calculation of turning flight paths as function of aircraft type and takeoff weight, and (3) development and use of more accurate attenuation data for extrapolation of measured levels to more distant points, both vertically and laterally (Author)

**A77-47625 \* Aircraft interior sandwich panel development** R A Anderson and G A Johnson (Boeing Commercial Airplane

Co., Seattle, Wash) *Journal of Fire and Flammability*, vol 8, July 1977, p 364-381 7 refs NASA-supported research

Three resin systems (bismaleimide, polyimide and modified phenolic) and several decorative films for use in aircraft interior panelling were subjected to flammability, smoke and gas emission, and toxicity testing. Cost, weight and appearance were also taken into account in assessing the feasibility of the materials for applications in passenger seating areas as well as in unoccupied compartments (galleys, lavatories, closets). Heat release studies and burn-through tests provided an additional measure of the fire safety characteristics of the panelling. A modified phenolic resin system and Tedlar-polycarbonate decorative film were selected as the most promising candidates for replacing conventional epoxy resin-impregnated fiberglass materials J M B

**A77-47667 # Calculation of the aerodynamic characteristics of a wing moving at subsonic speed, in the case of a weak shock-wave effect on the wing** (Raschet aerodinamicheskikh kharakteristik kryla, dvizhushchegosia s dozvukovoi skorost'iu, pri slabom vozdvoistvii na nego udarnoi volny) N A Gritsenko and M I Nisht *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, July-Aug 1977, p 149-154 In Russian

**A77-47669 # Configuration of free vortices trailing off a wing of finite span** (Forma svobodnykh vikhrei kryla konechnogo razmakha) A A Gruzdev *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, July-Aug 1977, p 159-163 10 refs In Russian

The progressive deformation of a pair of trailing vortices by their own induction is analyzed with allowance for the influence of the wing and the vortices attached to it. It is assumed that small periodic far-field disturbances are absent and that the rate of downwash is specified. A system of integrodifferential equations describing the motion of the vortices is solved by a successive approximation technique. The configuration of vortex filaments in the flow is identified, and the behavior of points along the vortex filaments at successive intervals of time is illustrated and discussed V P

**A77-47674 Rearrangement of vortex structures in the wake behind a body and in a jet** V I Likhoperskii and S G Popov (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) (*Moskovskii Universitet, Vestnik, Seriya I - Matematika, Mekhanika*, Mar-Apr 1977, p 106-112) *Moscow University Mechanics Bulletin*, vol 32, no 1-2, 1977, p 40-45 11 refs Translation

An investigation of vortex-street stability is conducted in which the decay and rearrangement of systems of point vortices in an ideal incompressible fluid are studied analytically. The analysis agrees with experiments in which symmetrical vortex streets are rearranged into checkerboard streets in a wake flow. It is confirmed that symmetrical vortex streets excited acoustically in a jet are rearranged symmetrically at  $h/l$  greater than 1 (where  $l$  is the distance between adjacent vortices of one row and  $h$  is the distance between rows) and then assume a checkerboard pattern B J

**A77-47675 Flight control I - The aircraft as controlled system** (Flugregelung I - Das Flugzeug als Regelstrecke) R Brockhaus (Braunschweig, Technische Universität, Braunschweig, West Germany) Munich, R Oldenbourg Verlag, 1977 239 p 66 refs In German \$14 20

Objectives and procedures of flight control are examined, taking into account flight control as a section of control technology, flight control in its relation to the performance of objectives of flight mechanics, a historical review of flight control developments, currently employed types of control systems, and new advances related to the area of flight control. The system of equations of aircraft dynamics is considered and aspects related to the characterization of aircraft dynamics are discussed. Attention is given to the definition of the parameters of flight mechanics, the derivation of the system of differential equations, a description of the forces

and moments which act upon the aircraft, wind effects, the linearization of the system of equations, its solution, the representation of the homogeneous solution with the aid of time vectors, approximation procedures for estimating the dynamical characteristics of the controlled system, and the reaction of the aircraft in response to signals G R

**A77-47699 #** The insertion or elimination of fuselage sections and the balancing of aircraft (Inserzione o rimozione di sezioni di fusoliera e centrimento dei velivoli) S Chiesa (Torino, Politecnico, Turin, Italy) *Ingegneria*, May-June 1977, p 129-134 In Italian

Equations describing the center of gravity for aircraft subject to various insertions or reductions of fuselage length, both in anterior and posterior positions, are given. The equations may be used in rebalancing aircraft or in the formulation of increased or decreased fuselage-capacity designs, as well as designs accommodating different engine capacities. The equations derived relate the longitudinal coordinate of the center of gravity to the length and weight of the inserted or eliminated section and to the location of the insertion or elimination; an iterative method is suggested for obtaining approximate analytical results J M B

**A77-47813 #** Royal Air Force assessment flights. D W Broughton (RAF College, Cranwell, Lincs., England) *Journal of Navigation*, vol 30, Sept 1977, p 339-343

Early transpolar and trans Atlantic flight tests of the Omega navigational system when the system was not fully operational (1973, 1976) are described. Omega error autocorrelation was checked with time, height and accuracy relations were checked, signal reception and loss of signal from distant stations are reported, and errors are described (cumulative frequency, % radial errors within circular error probability contour). Positioning of hardware used is outlined briefly R D V

**A77-47814 #** Flight experience with Omega R H N Bradley (Laker Airways, London, England) *Journal of Navigation*, vol 30, Sept 1977, p 343-352

Minor deviations from satisfactory performance are reported for the Omega navigation system in three years of flying experience with Omega backed up by Doppler. One hardware failure per year turned up (a timing card fault, 10 V power supply failure, and a stuck button), all detectable pre-flight, no in-flight equipment malfunctions occurred. Some off track excursions are to be corrected when VLF stations are added to the network. The lane ambiguity resolution program is seen as the major remaining difficulty and stumbling block to acceptance. Setting of flags, particularly the AMB (lane ambiguity) flag, in response to random and obscure causes, presenting warnings that 'may mean something or may mean nothing', is judged a recurring annoyance. Interactive use of the Omega and Doppler systems is found helpful R D V

**A77-47815 #** An American Omega navigation evaluation programme - 1975-1977 P R J Reynolds (Pan American World Airways, Inc., New York, N Y) *Journal of Navigation*, vol 30, Sept 1977, p 352-358

The evaluation program involved several phases of in-flight tests of Omega hardware systems on fifty-odd B-707/300 aircraft over a variety of trans-Atlantic, trans-Pacific, and Western Hemisphere (N-S) runs. Comparative costs of Omega vs inertial navigation system components and their effectiveness, worldwide availability of adequate Omega signal coverage, Omega in-lane accuracy and in-lane stability, hardware reliability, and operator compatibility of the control/display units were assessed. Types of Omega systems made available by different manufacturers, types of antennas, effects of sudden ionospheric disturbances and sudden phase anomalies, and modal interference were examined. Low-cost and practical 'crutches' for poor-coverage regions (such as far SW Pacific) are considered. A rubidium atomic clock and VLF signals stable to the Omega standard R D V

**A77-47816 #** Some mathematical aspects of air traffic systems V W Attwooll (Royal Aircraft Establishment, Air Traffic Studies Div., Farnborough, Hants, England) (*Royal Institute of Navigation, Meeting, London, England, Jan 26, 1977*) *Journal of Navigation*, vol 30, Sept 1977, p 394-411, Discussion, p 411-414 7 refs

Queuing problems applied to airport arrival and departure flows are discussed and debated. System capacity, channels available for stream flow, size (length) of queues, types of queues (steady-state or time-varying), departure runway queues and holding stack queues, waiting times and delays, random arrival times, and (customer) acceptance (servicing) rates are considered. Acceptance slots for regular and irregular arrivals, delays attributed to the airline company or to ATC or airport ground servicing, and ways of minimizing perturbations in schedules are considered, and results of some computer simulation studies are outlined. Cost penalties for delayed aircraft upsetting normal flows are weighed critically in the discussion R D V

**A77-47817 #** The presentation of information in combat aircraft L T J Salmon (Royal Aircraft Establishment, Farnborough, Hants., England) (*Royal Institute of Navigation, Meeting, London, England, Nov 17, 1976*) *Journal of Navigation*, vol 30, Sept 1977, p 415-421

Recent advances in computerized and automated navigation and navigation data display for combat aircraft are summarized and classified. Classification of navigation tasks and navigation aspects of combat missions distinguishes macronavigation (to the target area) and micronavigation (release and guiding of weapon onto target, with static or dynamic micronavigation depending on whether the target is stationary or mobile/random). Navigation-related features of over-water and overland reconnaissance missions and strike missions are contrasted, and projection displays and head-up displays of navigation data are compared R D V

**A77-47879** Computers and wind tunnels - Complementary aids to aircraft design A B Haines (Aircraft Research Association, Ltd., Bedford, England) *Aeronautical Journal*, vol 81, July 1977, p 306-321 48 refs

A survey of the life and career of Dietrich Kuchemann is presented with reference to his work on developing methods to calculate the flow over sweptback wings and alleviating adverse root and tip effects, and his research on the SST. Advances for external cowl design (e.g., a podded nacelle) and for three-dimensional sweptback wing-body combinations are described in full. Prospects and critical areas for combining the use of computers with wind tunnel experimentation are outlined, concluding that (1) the number of configurations needed for tunnel testing will be reduced, (2) the ability to forecast the aerodynamics of the full-scale aircraft would be increased, and (3) the quality of tunnel data and types of testing would be increased S C S

**A77-47950 #** Runway utilization coefficients (Il coefficiente di utilizzazione di pista) E Rosini (Aeronautica Militare, Servizio Meteorologico, Rome, Italy) *Rivista di Meteorologia Aeronautica*, vol 37, Apr-June 1977, p 145-148 In Italian

An index of the usability of airport runways which is dependent only on wind direction and velocity is discussed. In particular, monthly, seasonal and yearly levels of maximum wind velocity perpendicular and transverse to different runways are formulated using electronic data processing of synoptic wind velocity and direction measurements. Tables of utilization coefficients for Fiumicino Airport (Rome), which has 18 runway configurations, are given J M B.

## STAR ENTRIES

**N77-30065\*#** Amerind Publishing Co Pvt Ltd, New Delhi (India)

### SOVIET AIRCRAFT AND ROCKETS

N A Zhemchuzhin, M A Levin, I A Merkulov, V I Naumov O A Pozhdayev S P Frolov and V S Frolov 1977 277 p Transl into ENGLISH of the book 'Znakomtes, samolet i raketa' Moscow, Transport Publishers 1971 Sponsored by NASA (NASA-TT-F-770, TT-74-52007) Avail NTIS HC A13/MF A01 CSCL 01A

An overview of Soviet development and accomplishments in aeronautics and astronautics is presented along an assessment of the technologies required for aircraft or rocket flight

**N77-30066\*#** Amerind Publishing Co Pvt Ltd New Delhi (India)

### IN HERCULEAN FLIGHT

In its Soviet Aircraft and Rockets (NASA-TT-F-770) 1977 p 1-12 Transl into ENGLISH from the book 'Znakomtes, samolet i raketa' Moscow, Transport Publishers, 1971

Avail NTIS HC A13/MF A01 CSCL 01A

Major developments in the history of Soviet aviation are summarized and the objectives and accomplishments of various manned and unmanned space flight programs are discussed

A R H

**N77-30067\*#** Amerind Publishing Co Pvt Ltd, New Delhi (India)

### AIRCRAFT

In its Soviet Aircraft and Rockets (NASA-TT-F-770) 1977 p 24-80 Transl into ENGLISH from the book 'Znakomtes, samolet i raketa' Moscow, Transport Publishers 1971

Avail NTIS HC A13/MF A01 CSCL 01A

The physical principles of flight, and the consideration of atmospheric composition and aerodynamic forces in the design and construction of various types of aircraft are discussed Flight characteristics are described for helicopters, rotary-wing aircraft short and vertical takeoff aircraft, and tailless or variable geometry wing aircraft Flow characteristics at various speeds are also discussed

A R H

**N77-30068\*#** Amerind Publishing Co Pvt Ltd, New Delhi (India)

### AIRCRAFT ENGINES

In its Soviet Aircraft and Rockets (NASA-TT-F-770) 1977 p 81-139 Transl into ENGLISH from the book 'Znakomtes, samolet i raketa' Moscow, Transport Publishers, 1971

Avail NTIS HC A13/MF A01 CSCL 21E

Thrust and weight requirements of aircraft engines in general are discussed The characteristics and operating principles of various types of jet, breathing and rocket engines are described

A R H

**N77-30069\*#** Amerind Publishing Co Pvt Ltd New Delhi (India)

### AIRCRAFT EQUIPMENT

In its Soviet Aircraft and Rockets (NASA-TT-F-770) 1977 p 140-157 Transl into ENGLISH from the book 'Znakomtes, samolet i raketa' Moscow, Transport Publisher, 1971

Avail NTIS HC A13/MF A01 CSCL 01D

The complex of functionally interconnected instruments and devices for controlling flight engine operations electrical systems communications and vital systems for passengers and crew is described The aggregates of the aircraft automatic equipment are also discussed

A R H

**N77-30070\*#** Amerind Publishing Co Pvt Ltd New Delhi (India)

### INSTRUMENTS AND METHOD OF AIR NAVIGATION

In its Soviet Aircraft and Rockets (NASA-TT-F-770) 1977 p 158-177 Transl into ENGLISH from the book 'Znakomtes, samolet i raketa' Moscow Transport Publishers, 1971

Avail NTIS HC A13/MF A01 CSCL 17G

Topics discussed include magnetic and astronavigation instruments, flight beyond ground visibility aircraft radio navigation instruments and communication radio sets, instrument landing systems and ground controlled landing systems

A R H

**N77-30071\*#** Amerind Publishing Co Pvt Ltd New Delhi (India)

### AIRCRAFT CYBERNETICS

In its Soviet Aircraft and Rockets (NASA-TT-F-770) 1977 p 178-197 Transl into ENGLISH from the book 'Znakomtes, samolet i raketa' Moscow Transport Publishers, 1971

Avail NTIS HC A13/MF A01 CSCL 01C

The use of computers for aircraft control, flight simulation, and inertial navigation is explored The man-machine relation problem in aviation is addressed Simple and self-adapting autopilots are described and the assets and liabilities of digital navigation techniques are assessed

A R H

**N77-30073#** Army Aviation Systems Command, St Louis Mo Systems Analysis Office

### FLYING, MAINTENANCE, AND THE SALE OF PARTS TO THE FIELD INTERACTIVE MODELS FOR AH-1 AND CH-47 SYSTEMS Final Report

Valentin C Berger and Blaine T Stone Apr 1977 61 p refs (AD-A039193, DRSAB-D-77-6, USAVSCOM-TR-77-24) Avail NTIS HC A04/MF A01 CSCL 01/3

Computer-generated graphic displays are used to investigate the relationships of AH-1 and CH-47 fleet flying hours, and of maintenance occurrences of short and long duration during selected peacetime and wartime (RVN) periods The rationale for observed relationships is explored in detail and the discussion is supported with the results of correlation analyses A similar approach is used to explore the relationships existing between monthly gross sales of stock-funded airframe parts to the field and the number of short and long duration maintenance events, and between those sales and monthly fleet flying hours The AH-1 and CH-47 fleets are examined during a peacetime period of 1-1/2 fiscal years The two elements of the study are shown to be complementary and suitable for the construction of interactive models of operations and supply support A probable connection is postulated between managed field maintenance support activities and the cost-effectiveness of On Condition Maintenance (OCM) world-wide team visits

GRA

**N77-30074#** Battelle Columbus Labs, Ohio

### ARMY AVIATION MANUFACTURING TECHNOLOGY PROGRAM GUIDANCE Final Report, 1 Feb 1975 - 17 May 1976

H J Henning and T G Byrer Jun 1976 156 p refs (Contract DAAJ01-75-C-0448) (AD-A040821, DRSAB-76-30) Avail NTIS HC A08/MF A01 CSCL 01/3

This program is aimed at formulating a realistic five year plan for developing and implementing advanced manufacturing technologies to the production of Army helicopters and recommending modifications in the operation of the Army Aviation Manufacturing Technology program to realistically accommodate the plan  
 Author (GRA)

**N77-30079** Air Force Inst of Tech Wright-Patterson AFB, Ohio  
**NUMERICAL SOLUTION OF THE CONICALLY SYMMETRIC NAVIER-STOKES EQUATIONS FOR HYPERSONIC FLOW AT ANGLE OF ATTACK** Ph D Thesis  
 David Scott McRae 1976 113 p  
 Avail Univ Microfilms Order No 77-9475

Solutions were obtained for hypersonic flow over sharp cones at high angle of attack by integrating the Navier-Stokes equations subject to a conical symmetry assumption A physically based technique (normal stress damping) was demonstrated for controlling starting transients and for reducing or eliminating numerical oscillations occurring at shock discontinuities during the integration The general features which appeared in experiment were shown to appear in the results of the integration, including the proper behavior in laminar flow, of the viscous layer and the vortical singularity The adequacy of the conical symmetry assumption is indicated for the turbulent regime on conical bodies  
 Dissert Abstr

**N77-30085\*** Old Dominion Univ Research Foundation Norfolk Va  
**EXPERIMENT AND ANALYSIS ON THE FLOW PROCESS DYNAMICS OF THE NASA-LANGLEY EIGHT FOOT TRANSONIC PRESSURE TUNNEL** Semiannual Progress Report, 1 May 1976 - 28 Feb 1977  
 Ping Tchong (Old Dominion Univ) 28 Feb 1977 39 p  
 (Grant NSG-1079)  
 (NASA-CR-154806) Avail NTIS HC A03/MF A01 CSCL 01A

A dynamic response test performed in a eight foot transonic pressure tunnel is described The dynamics of the flow process of the wind tunnel at transonic conditions were obtained Descriptions of the test conditions, instrumentation presentation of raw data analysis of data, and finally based on experimental evidences, an attempt to construct an input output relationship of the flow process from the viewpoints of control engineering are included  
 Author

**N77-30086\*** Flow Research Inc, Kent Wash  
**STUDY OF DESIGN AND ANALYSIS METHODS FOR TRANSONIC FLOW** Final Report  
 Earl M Murman Jul 1977 14 p refs  
 (Contract NAS2-8847)  
 (NASA-CR-152041 NOTE-118) Avail NTIS HC A02/MF A01 CSCL 01A

An airfoil design program and a boundary layer analysis were developed Boundary conditions were derived for ventilated transonic wind tunnels and performing transonic windtunnel wall calculations A computational procedure for rotational transonic flow in engine inlet throats was formulated Results and conclusions are summarized  
 Author

**N77-30087\*** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany)  
**EXPERIMENTAL INVESTIGATION CONCERNING THE REDUCTION OF WAVE DRAG OF POINTED SYMMETRICAL WINGS OF EQUAL VOLUME WITH SUBSONIC LEADING EDGE AND BELL-SHAPED PLANFORM FOR DIFFERENT THICKNESS DISTRIBUTIONS IN THE SPANWISE AND CHORDWISE DIRECTIONS**  
 Friedrich Keunes 15 Sep 1975 38 p refs In GERMAN ENGLISH summary Translation was announced as N76-30175 (DLR-FB-75-62) Avail NTIS HC A03/MF A01 DFVLR Cologne DM 15 40

Drag measurements were made for a family of wings in a 30 by 30 sq cm supersonic wind tunnel to test the theory that zero lift wave drag for pointed symmetrical wings of finite thickness

and equal volume may be reduced by varying the wing planform and the chordwise and spanwise thickness distribution Because of the influence of the model support and the approximate estimate of the skin friction necessary for determining the wave drag, no agreement was found with the theory which is valid for the wave drag of wings only The flow behavior during the tests indicate that the shock wave boundary layer interaction must be considered  
 Author

**N77-30088\*** Boeing Vertol Co, Philadelphia Pa  
**COMPARISON OF DYNAMIC STALL PHENOMENA FOR PITCHING AND VERTICAL TRANSLATION MOTIONS** Final Report  
 T Fukushima and L U Dadone Washington NASA Jul 1977 184 p refs Sponsored in part by US Army  
 (Contract NAS1-14056)  
 (NASA-CR-2793, D238-10007-1) Avail NTIS HC A09/MF A01 CSCL 01A

Test data for vertical translation motions of the V0012 and V23010-1 58 airfoils were compared with force pitch and oscillation data to determine qualitative differences in dynamic stall behavior Chordwise differential pressure variations were examined in detail for the test conditions displaying dynamic stall The comparison revealed a number of differences both in the onset of stall and in the progression separation as a function of the type of motion The evidence of secondary stall events following the recovery from initial stall were found to be dependent on the type of motion, but additional data will be needed to incorporate vertical translation effects into the empirical approximation of dynamic stall  
 Author

**N77-30089\*** National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio  
**COLD AIR PERFORMANCE OF A 12 766-CENTIMETER-TIP-DIAMETER AXIAL-FLOW COOLED TURBINE 2 EFFECT OF AIR EJECTION ON TURBINE PERFORMANCE**  
 Jeffrey E Haas and Milton G Kofskey Aug 1977 37 p refs  
 Prepared in cooperation with Army Air Mobility Res and Develop Lab Cleveland  
 (NASA-TP-1018) Avail NTIS HC A03/MF A01 CSCL 21E

An air cooled version of a single-stage, axial-flow turbine was investigated to determine aerodynamic performance with and without air ejection from the stator and rotor blades surfaces to simulate the effect of cooling air discharge Air ejection rate was varied from 0 to 10 percent of turbine mass flow for both the stator and the rotor A primary-to-air ejection temperature ratio of about 1 was maintained  
 Author

**N77-30092\*** Analytical Sciences Corp, Reading, Mass  
**AN EXTENDED KALMAN FILTER FOR ESTIMATING AERODYNAMIC COEFFICIENTS** Final Report, Sep. 1975 - Sep 1976  
 Charles M Brown, Jr Eglin AFB Fla AFATL Dec 1976 71 p refs  
 (Contract F08635-76-C-0117)  
 (AD-A040594, TASC-TR-636-1, AFATL-TR-158) Avail NTIS HC A04/MF A01 CSCL 20/4

This report describes an extended Kalman filter (EKF) algorithm developed to estimate the aerodynamic coefficients of projectiles based on discrete free-flight trajectory measurements These measurements consist of three spatial positions and three angular orientations, relative to a fixed inertial coordinate system and time-of-flight at 50 downrange positions along the trajectory The algorithm is based upon a nonlinear six-degree-of-freedom model of a rotationally symmetric rigid body, and it incorporates a stochastic measurement model that approximates the conditions which exist in a ballistic test range  
 GRA

**N77-30094#** National Aerospace Lab., Amsterdam (Netherlands)  
Flight Dynamics Div  
**AERODYNAMIC DATA AND OFF-DESIGN CHARACTERISTICS OF THE MODIFIED QUASI-ELLIPTICAL AIRFOIL SECTION NLR 7101**

J Zwaaneveld 3 Feb 1976 40 p refs  
(Contract NIVR-1723)

(NLR-TR-76012-U) Avail NTIS HC A03/MF A01

Transonic wind tunnel tests were performed to determine the two dimensional aerodynamic characteristics of the 14.1 % thick modified quasi-elliptical airfoil section NLR 7101. The modification concerns the introduction of aft-camber in order to obtain rear loading. The tests were conducted in the NLR Pilot Tunnel at Mach numbers ranging from 0.3 to 0.825 at angles of attack up to maximum lift. The Reynolds number based on the chord was about two million at the design condition. Lift, drag, and pitching moment coefficients are presented and off-design characteristics in terms of drag divergence onset of rear separation, lift divergence and maximum lift are discussed.

Author (ESA)

**N77-30095#** Technische Hochschule, Darmstadt (West Germany) Inst fuer Flugtechnik

**SYSTEMATIC PRESSURE DISTRIBUTION AND FORCE MEASUREMENTS OF TWO YAWED SLENDER WINGS [SYSTEMATISCHE DRUCKVERTEILUNGS- UND KRAFTMESSUNGEN AN ZWEI SCHIEBENDEN SCHLANKEN FLUEGELN]**

Bernhard Wagner 9 Feb 1976 125 p refs in GERMAN  
Sponsored by Deut Forschungsgemeinschaft  
(IFD-2/76/I) Avail NTIS HC A06/MF A01

Pressure distribution and force measurements were carried out on two thin slender wings over a wide yaw and angle of attack range in a wind tunnel. The main object of the investigations was a comparison of the linear slender wing theory with measurements at small angle of attack especially for the case of a vortex sheet coming from a lateral edge during yawed flight. Measurements were also carried out at larger angles of attack in order to prepare test results for a possible transfer of the aspiration force analogy to arbitrary wing forms and to yawed wings.

ESA

**N77-30096#** Technische Hochschule, Darmstadt (West Germany) Inst fuer Flugtechnik

**A METHOD FOR CALCULATING FLOW AROUND A YAWED SLENDER WING AT SMALL ANGLE OF ATTACK [EIN VERFAHREN ZUR BERECHNUNG DER STROEMUNG UM SCHIEBENDE SCHLANKE FLUEGEL BEI KLEINER ANSTELUNG]**

Bernhard Wagner 29 Feb 1976 63 p refs in GERMAN  
(IFD-4/76) Avail NTIS HC A04/MF A01

An extension of Jones' slender wing theory is proposed, which takes into account a vortex sheet coming from a lateral edge during yawed flight. The integral equation for the vorticity of the wake region is solved stepwise by discretization. Formulas are developed for the vorticity, pressure distribution, and aerodynamic coefficients of slender wings of arbitrary planform. The limiting case of the infinitely long yawed wing is considered separately.

ESA

**N77-30097#** Technische Hochschule, Darmstadt (West Germany) Inst fuer Flugtechnik

**SOME QUADRATURE METHODS FOR LIFTING WING THEORY [UEBER EINIGE QUADRATURVERFAHREN FUER DIE TRAGFLUEGELTHEORIE]**

Xaver Hafer and Bernhard Wagner 1977 28 p refs in GERMAN

(IFD-5/76) Avail NTIS HC A03/MF A01

A method is described for the quadrature in span width direction which employs the properties of orthogonal polynomials similar to the method of Multhopp and Van de Vooren. The quadrature is also executed over each half span width. The effectiveness of the method was investigated by sample calculations for the extended lifting line theory.

ESA

**N77-30099#** Naval Postgraduate School, Monterey, Calif  
**STATISTICAL ANALYSIS OF US NAVY MAJOR AIRCRAFT ACCIDENT RATES, PILOT AND AIRCRAFT TIME-DEPENDENT VARIABLES M S Thesis**

Abdur Rashid Mar 1977 63 p refs

(AD-A040096) Avail NTIS HC A04/MF A01 CSCL 01/2

Aircraft accident rates by month were analyzed for randomness, cyclic pattern or increasing/decreasing trends for all attack, fighter and propeller type aircraft. The technique of Runs test was employed to the runs above and below the median. The analysis of pilot/aircraft time dependent variables was also done for both accident and non-accident pilots/aircrafts. The hypothesis tested was, the accidents per hundred pilots/aircrafts were the same for each category of pilot/aircraft variable. The chi square one sample test, the chi square test for K independent samples and the Mann-Whitney U test were used for the analysis. The aircrafts considered for the analysis of pilot variables were A-4, A-7 and F-4, and the aircraft considered for the analysis of aircraft variable was F-4.

Author (GRA)

**N77-30100#** BioTechnology, Inc. Falls Church, Va  
**FORMAT PRACTICES FOR DOCUMENTING TIME CRITICAL HAZARDOUS PROCEDURES Final Report**

Theodore J Post Jun 1976 32 p refs

(Contract N00014-72-C-0101)

(AD-A036369) Avail NTIS HC A03/MF A01 CSCL 01/3

The report relates to a study to determine whether reformatting relevant sections of the pilots Naval Air Training and Operating Procedures Standardization manual was a feasible means of improving the success achieved in ejecting from disabled aircraft.

GRA

**N77-30101\*#** Ohio Univ., Athens Dept of Electrical Engineering

**INTERACTIVE LORAN-C TO GEOGRAPHIC AND GEOGRAPHIC-TO-LORAN-C COMPUTATION**

Lynn M Piecuch and Robert W Lilley Aug 1977 6 p refs  
(Grant NGR-36-009-017)

(NASA-CR-153985, TM-52) Avail NTIS HC A02/MF A01 CSCL 17G

The LORAN program is stored in CMS disk files for use by Avionics Engineering Center terminal users. A CMS EXEC file named LORAN controls program operation. The user types LORAN and the program then prompts for data input and produces output on the terminal. The FORTRAN program refers to a disk file of LORAN master data giving station locations, coding delays, repetition rate and station pair identification letters. For Geographic-to-LORAN conversion, no iterative computations are required; the program is a straightforward coordinate conversion based upon the techniques described by the Navy. For LORAN-to-Geographic conversion, the original Navy program required a dead-reckoned position, near the actual unknown fix, to begin computations. No iteration was performed to obtain the LORAN fix, but internal program errors occurred at execution time if the dead-reckoned fix were displaced from the actual fix by more than a few minutes of latitude or longitude. In order to enhance usefulness of the program for the terminal user an iterative routine was added which allows a single dead-reckoned position to be entered from the master data file for each LORAN chain. The results compare exactly with the LORAN-C navigation chart and provide adequate benchmark data for general aviation flight planning and data analysis.

Author

**N77-30102#** National Bureau of Standards, Washington, D C  
Inst for Basic Standards

**VISUAL RANGE CONCEPTS, INSTRUMENTAL DETERMINATION, AND AVIATION APPLICATIONS**

C A Douglas and R L Booker Jun 1977 362 p refs  
Sponsored by the FAA

(NBS-Mono-159 LC-77-7343) Avail NTIS MF A01. SOD HC \$5 00

Principles, procedures and instruments used in the measurement of visual range are reviewed. The fundamental concepts of the visual range of objects and lights are discussed. Operational aspects of the several classes of atmospheric attenuation meters



are reviewed and representative instruments are described. The development of the NBS transmissometer its validation and application to aviation operations is presented. An error analysis is made of the effects of instrument errors and of differences in observer thresholds on visibility measurements. A chronological review of the development and application of the runway visual range concept is included together with a discussion of cloud height measurements. Author

**N77-30103#** Missouri Univ., Rolla Dept of Electrical Engineering  
**NAVIGATION CHECKPOINTING USING HORIZON CORRELATION Final Report, 1 Mar 1975 - 28 Feb 1977**  
 Gordon E Carlson Apr 1977 30 p refs  
 (Contract N00014-75-C-0639, NR Proj 387-076)  
 (AD-A039946, CSR-77-5) Avail NTIS HC A03/MF A01 CSCL 17/7

A summary of the analysis performed on the horizon correlation navigation checkpointing system is presented. This includes a brief description of the system concept and the analysis techniques used. The tradeoff and performance results are summarized and indicate that the theoretical feasibility of the system has been established. Author (GRA)

**N77-30104#** Sandia Labs, Albuquerque, N Mex  
**SIMULATION OF INERTIAL INPUTS TO A STRAPDOWN PLATFORM FOR INERTIAL GREAT CIRCLE TRAJECTORIES**  
 Farrell J Perdreauville Jan 1977 28 p refs  
 (Contract E(29-1)-789)  
 (SAND-76-0620) Avail NTIS HC A03/MF A01

Equations are developed for computing inertial accelerations and angular rates that would be measured by the accelerometers and gyroscopes in a strapdown inertial platform. The accelerations and angular rates are computed for a body that is moving in an inertial great circle trajectory. A FORTRAN computer code which implements the calculations is listed. ERA

**N77-30105#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany) Inst fuer Flugfuehrung  
**MONTE CARLO SIMULATIONS OF VOR/DME HOLDING PROCEDURES BASIC IDEAS AND APPLICATIONS**  
 Holger Schnuerer 17 Mar 1977 25 p refs In GERMAN, ENGLISH summary. Report will also be announced as translation (ESA-TT-419)  
 (DLR-FB-77-08) Avail NTIS HC A02/MF A01, DFVLR Cologne DM 13 70

Using DME in addition to VOR allows a better use of the airspace for holding procedures in civil aviation. As yet there are no procedures for the construction of the airspace to be reserved for a safe execution of these holding procedures, which have been agreed by the international authorities. A method for the construction of holding areas of different probabilities is described, where the simulation of flight paths in a computer using the Monte-Carlo technique has a special importance. The simulation allows the application of an extensive and detailed error model. In addition the locally different physical conditions may be taken into consideration. Both factors are most important for a safe and economical use of the airspace. Author (ESA)

**N77-30106#** Naval Postgraduate School Monterey, Calif  
**INTRODUCTORY INVESTIGATION OF THE RANGE MEASURING SYSTEM/DATA COLLECTION SYSTEM (RMS-2/DCS) M S Thesis**  
 William F H Berthiaume Mar 1977 62 p refs  
 (AD-A039921) Avail NTIS HC A04/MF A01 CSCL 17/7  
 Various aspects of the operation of the Range Measuring System/Data Collection System (RMS-2/DCS), which is employed by the United States Army Combat Developments Experimentation Command (USACDEC) at the Hunter Liggett Military Reservation, California, were investigated. System development, operation and reliability were summarized and two problem areas associated with RMS-2/DCS identified. Author (GRA)

**N77-30107#** LTV Aerospace Corp, Dallas, Tex Vought Systems Div

**F-8 OBLIQUE WING STRUCTURAL FEASIBILITY STUDY**  
 E Koltko, A Katz, M A Bell, W D Smith, R Lauridia, C T Overstreet, C Klapprott, T F Orr, C L Jobe, and F G Wyatt  
 Nov 1975 151 p refs  
 (Contract NAS4-2266)  
 (NASA-CR-154841, Rept-2-57000/5R-3239) Avail NTIS HC A08/MF A01 CSCL 01C

The feasibility of fitting a rotating oblique wing on an F-8 aircraft to produce a full scale manned prototype capable of operating in the transonic and supersonic speed range was investigated. The strength, aeroelasticity, and fatigue life of such a prototype are analyzed. Concepts are developed for a new wing a pivot a skewing mechanism, control systems that operate through the pivot and a wing support assembly that attaches in the F-8 wing cavity. The modification of the two-place NTF-8A aircraft to the oblique wing configuration is discussed. Author

**N77-30108#** Naval Air Test Center, Patuxent River, Md  
**A PROGRAM FOR INCREASED FLIGHT FIDELITY IN HELICOPTER SIMULATION**  
 C Woerner and D Canico 27 Apr 1977 22 p refs  
 (AD-A039324, NATC-TM-77-1-RW) Avail NTIS HC A02/MF A01 CSCL 14/2

Increased emphasis has been placed on the need for and usefulness of major aviation training devices - flight simulators. A description of a modern trainer and the status of current simulation is provided. High fidelity is necessary to achieve high training transfer to the aircraft. The authors describe the need for and a proposed basic approach to technical simulator flight testing designed to achieve high fidelity. Ideas were formulated as a result of the authors' participation in the development and validation of the SH-2 F Weapons System Trainer Device 2. F106 Navairtestcen participates in the program as a technical advisor on flight fidelity. Major contributions are aircraft testing for the establishment of criteria data followed by simulator evaluation both performed by engineering test pilots and flight test engineers. These evaluations used established and disciplined flight test techniques and should be common place in the development and validation of flight trainers. An extensive table of criteria data tests is provided for reference. Typical instrumentation tables for both the aircraft and trainer are included. Specific comments are made concerning trainer testing problems and the priorities of tests. A discussion is included on simulator data gathering techniques, appropriate parameters and equipment needed. The scope of a visual system evaluation is presented, along with a description of its usefulness in additional testing of the basic trainer. Author (GRA)

**N77-30109#** Naval Postgraduate School Monterey, Calif  
**ENERGY MANAGEMENT DISPLAY FOR AIR COMBAT MANEUVERING M S Thesis**  
 Stuart Robinson Powrie Mar 1977 90 p refs  
 (AD-A040198) Avail NTIS HC A05/MF A01 CSCL 01/4

A skill and task analysis of air combat maneuvering was performed. This analysis indicated that a device to aid the pilot to maneuver the aircraft to its aerodynamic limits might be useful, but such a device might be ineffective due to a high level of sensory saturation. The concept for design of the project was predicated upon projected use of future displays for fighter aircraft in air combat maneuvering, pilot training and flight safety aspects. The test energy maneuverability display was designed using a microprocessor for dedicated control. The display format was based on color coding various specific power regions and presenting them in the pilot's peripheral vision. An experiment was designed and executed to determine if the pilot could respond to the specific power color codes and maintain performance of critical pilot tasks. An analysis of test variance indicated no significant degradation of pilot performance with the introduction of color coding to the peripheral vision. Author (GRA)

**N77-30110#** Rock Island Arsenal, Ill General Thomas J Rodman Lab

# **AIRCRAFT GUN ICING EVALUATION**

Max L Coppock and Merrill D Gerke Jan 1977 135 p  
(AD-A039834, RIA-R-TR-77-021) Avail NTIS  
HC A07/MF A01 CSCL 19/6

This report discusses the results of icing tests conducted on the M28A1 Turret the 7.62mm M134 Gun the 40mm, M129 Grenade Launcher and the 20mm, M195 Gun. The results indicate that all of the weapons can be fired without catastrophic damage after accumulating as much as 1 1/4 inches ice on the muzzle. The use of gas deflectors and/or flash suppressors allow the weapons to be fired without any damage occurring from ice accumulation of up to 1 1/4 inches. The turret suffered only minor limitations of movement when coated with 1 1/4 inches of ice. The extreme limits of elevation could not be attained due to ice jamming the stops but about 85 percent of the excursion distance was operable. A build-up of over 3/8 inches of ice on one side of the turret will limit the azimuth movement in one direction only. A heavy ice build-up cannot pass the close gap between turret and aircraft fairing behind the turret. This situation can be prevented by pointing the guns into the wind causing the ice build-up to be on the front turret surface.

Author (GRA)

# **N77-30111# Naval Postgraduate School Monterey, Calif DECISION-MAKING AND OPTIMIZATION IN AIRCRAFT DESIGN**

Ulrich Haupt Feb 1977 61 p refs  
(AD-A039464, NPS-67HP77021A) Avail NTIS  
HC A04/MF A01 CSCL 01/2

The state of the art in aircraft design is surveyed with regard to the decision-making process. It is shown that the empirical approach to decision-making as it is generally practiced in hardware design has inherent limitations. There is an increasing need to consider uncertainties and preferences explicitly. This leads to a new design outlook combining the experience of old-time designers with an analytical approach to complex problems. An outline is given for the development of practice-oriented text material as a most essential step toward preparing engineers for new tasks in design and decision-making.

Author (GRA)

# **N77-30112# Naval Air Test Center Patuxent River Md THE DEVELOPMENT OF PRIMARY EQUATIONS FOR THE USE OF ON-BOARD ACCELEROMETERS IN DETERMINING AIRCRAFT PERFORMANCE**

W R Simpson 19 Apr 1977 28 p refs  
(AD-A039174, NATC-TM-76-3-5A, Avail NTIS  
HC A03/MF A01 CSCL 01/1)

Primary equations for the use of on-board accelerometer data (both flight path and body mounted) for determining aircraft performance are developed. Primary equations are those mathematical relationships which relate measured quantities to useful parameters. They are distinguished from secondary and analysis equations in that the latter are used to either standardize or separate effects in the data. Reference materials are cited, or methods are presented for obtaining all parameters necessary in the use of the primary equations. In cases where sufficient reference materials are not available, the equations are derived. An equation summary is presented for the user who does not wish to go through the development procedures.

Author (GRA)

# **N77-30113# Naval Ship Research and Development Center, Bethesda, Md Ship Performance Dept SEAKEEPING CHARACTERISTICS OF A PRELIMINARY DESIGN FOR A SEA LOITER AIRCRAFT**

Alvin Gersten Jose Bonilla-Norat, and Lawrence Murray Feb 1977 137 p refs  
(AD-A040062, SPD-748-02) Avail NTIS HC A07/MF A01  
CSCL 01/3

A model of a proposed sea loiter aircraft has undergone experiments in the hullborne model at various headings to regular and random waves. The principal goal of the investigation was to provide data for evaluating the habitability characteristics of

this concept. The results will also be used to validate computer predictions. Transfer functions are presented in this report, as are plots and tables of standard deviation values and significant values of vehicle response in a seaway. The effect on motions of varying model weight and the effectiveness of damping plates in reducing motions are discussed. In general, neither of these is found to significantly alter the unusual transfer functions obtained for this craft. The motions of a buoy, whose configuration was selected to provide wave surface following characteristics and which was also subjected to waves in the towing tank, are discussed in an appendix.

Author (GRA)

# **N77-30114# Naval Weapons Center China Lake, Calif GATOR/AV-8A ENVIRONMENTAL CAPTIVE FLIGHT VIBRATION RESPONSE TESTS Final Report, Oct 1974 - Jan. 1976**

K T Katsumoto and W W Paramenter Feb 1977 104 p  
(AD-A036498, NWC-TP-5883) Avail NTIS HC A06/MF A01  
CSCL 01/3

A series of flights using an AV-8A aircraft and the GATOR weapon (Navy version Mk 7 dispenser) were made. Vibration and acoustic responses were measured for this externally carried ordnance during typical flight conditions. Acceleration power spectral density plots are presented and test levels are recommended.

GRA

# **N77-30115# Auburn Univ Ala Engineering Experiment Station**

**AUTOMATIC TARGET HAND-OFF USING CORRELATION  
TECHNIQUES Final Report, 5 Dec 1975 - 31 Jan 1977**  
J S Boland III, L J Prinson, G R Kane, M A Honnell, and  
E G Peters 31 Jan 1977 145 p refs  
(Contract DAAH01-76-C-0396)

(AD-A036435) Avail NTIS HC A07/MF A01 CSCL 17/8  
The problem of automatic hand-off of a target from a precision pointing and tracking system (PTS) to an imaging missile seeker is considered in this report. The approach taken is to search for the target in the seeker field of view (FOV) using the PTS video as a reference. When the target is located the seeker line of sight is adjusted automatically such that the target is at the center of its FOV at which point the seeker tracker can lock on to the target. Location of the target in the seeker FOV can best be accomplished using correlation techniques. The approach taken is to consider the most accurate but yet most costly in computation time and hardware requirements. Tradeoffs are then considered in order to obtain a real-time correlator (i.e. one which can compute the correlation surface at the rate of the incoming live video from the seeker). The effect of these trade-offs on correlation accuracy and other system performance criteria is given. A correlation algorithm is chosen and an implementation of this algorithm is given. An alternate implementation using an analog adder rather than a digital adder tree is recommended.

GRA

# **N77-30116# Bolt, Beranek, and Newman, Inc Cambridge, Mass DEVELOPMENT OF PROTOTYPE OPTICAL CONVOLUTION AIRSPEED SENSOR Final Report, Jan - Sep 1976**

Michael J Rudd Wright-Patterson AFB, Ohio AFFDL Jan 1977 89 p refs  
(Contract F33615-76-C-3051, AF Proj 1987)  
(AD-A039469, BBN-3380, AFFDL-TR-76-132) Avail NTIS  
HC A05/MF A01 CSCL 01/4

This report describes the continued development of the Optical Convolution Airspeed Indicator. This relatively inexpensive instrument measures true airspeed by projecting a shadowgraph image of the wake from a small heater onto grating and measuring the ripple frequency of the turbulence crossing the grating. Measurements were made on the structure of the turbulent wake so that the heater size and grating can be optimized. A new type of signal processor called a correlation discriminator, was developed to measure the frequency of the signal in the presence of a large amount of noise. An active heater protection circuit was built to prevent it from burning out when there is no air flow. The effects of environmental conditions on the sensor

were examined and they can all be met although the effects of rain and icing require further study. A new improved Prototype Mark 2 was built and tested. There were significant changes in reading at angles of attack and sideslip above 10 to 15 deg. GRA

**N77-30117#** Naval Postgraduate School, Monterey, Calif  
**AN EVALUATION OF A MASTER SCAN DISPLAY FOR USE IN AN AIRCRAFT INFORMATION HANDLING SYSTEM** M S Thesis

Walton Lewis Hogan, Jr. Mar 1977 99 p refs  
(AD-A039652) Avail NTIS MF A01 CSCL 09/2

The work described herein was part of continuing research in the area of computer aided information management and display as applied to air operations on an aircraft carrier. The purpose of this study was to evaluate the Hughes CONOGRAPHIC-12 Graphics Display Terminal in a computer graphics-aided aircraft information handling system. The approach taken in this study was to implement a realistic aircraft information handling system on a Digital Equipment Corporation PDP-11/50 minicomputer within the conventions of the C programming language and the UNIX operating system at the Naval Postgraduate School Computer Laboratory. The study includes a description of previous efforts in the area, a description of the CONOGRAPHIC-12 hardware and the software written to evaluate the display terminal. The study also includes an evaluation of the CONOGRAPHIC-12 display terminal as both a dynamic interactive display terminal and a repeater-only terminal at six representative stations.

Author (GRA)

**N77-30118#** Vought Corp., Dallas, Tex  
**MASTER MONITOR DISPLAY APPLICATIONS STUDY FOR THE A-7E** Final Report, Mar 1976 - Jan 1977  
R H Sanderlin and P E Greer Jan 1977 82 p  
(Contract N62269-76-C-0198)

(AD-A039882, Rept-2-57110-TR-3367, NADC-77075-30) Avail NTIS HC A05/MF A01 CSCL 01/4

A study program to define the conceptual requirements and implementation schemes for the incorporation of a Master Monitor Display (MMD) into an A-7E has been completed. The study identifies the candidate functions for display on the MMD that were selected from the existing A-7E cockpit functions, defines what is to be displayed on the MMD corresponding to the current warnings, cautions, advisories and auxiliary data with reference to flight modes, and defines the implementation interface requirements. The study results reported in this document verify the feasibility of utilizing the integrated display concept in an A-7E aircraft to replace certain cockpit functions presently performed with dedicated indicators and instruments.

Author (GRA)

**N77-30119\*#** Naval Air Propulsion Test Center, Trenton, NJ  
**ROTOR BURST PROTECTION PROGRAM EXPERIMENTATION TO PROVIDE GUIDELINES FOR THE DESIGN OF TURBINE ROTOR BURST FRAGMENT CONTAINMENT RINGS** Final Report, 1 1972 - 1976

G J Mangano, J T Salvino, and R A DeLucia Mar 1977 53 p refs  
(NASA-CR-135166, NAPTC-PE-98) Avail NTIS HC A04/MF A01 CSCL 21E

The results of a program of rotor burst containment experimentation that provides guidelines for the design of optimum weight turbine rotor disk fragment containment rings are presented. The guidelines were derived by establishing the relationships between a measure of the ring's capability to contain fragment energy with respect to its weight and other significant ring and rotor variables such as the (1) rotor tip diameter (2) number of rotor fragments, and (3) ring radial thickness and axial length. The experiments consisted mainly of bursting 14 and 31 inch diameter turbine rotors into encircling containment rings made from centrifugally cast 4130 steel. Rules are given for achieving optimum weight ring designs. Author

**N77-30120#** Rockwell International Corp., Columbus, Ohio  
Aircraft Div

**FLIGHT TEST OF AN 8000 psi LIGHTWEIGHT HYDRAULIC SYSTEM (LHS)** Final Report, 23 Jun 1976 - 23 Apr 1977  
Joseph N Demarchi and Robert K Haning Apr 1977 88 p refs

(Contract N62269-76-C-0254)

(AD-A039717, NR77H-21, NADC-77098-30) Avail NTIS MF A01 CSCL 13/7

An 8000 psi hydraulic lateral control system was installed in a T-2C airplane. Four pilots evaluated the test installation, accumulating 115 flight hours. Operational characteristics were very similar to the original 3000 psi system. The 8000 psi installation functioned exceptionally well. Successful completion of this project confirmed that 8000 psi lightweight hydraulic systems can be designed, fabricated, and maintained without special techniques or state-of-the-art advances. Author (GRA)

**N77-30121#** Detroit Diesel Allison Indianapolis, Ind  
**AN EXPERIMENTAL INVESTIGATION OF A SUBSCALE VARIABLE PRESSURE RATIO HIGH THRU FLOW TURBINE** Final Technical Report, Jan - Dec. 1976

D J Helton, H G Lueders, and J R Arvin Wright-Patterson AFB Ohio AFAPL Feb 1977 91 p

(Contract F33615-76-C-2068, AF Proj 3066)

(AD-A039823L, AFAPL-TR-77-7) Avail NTIS HC A05/MF A01 CSCL 21/5

This program investigates the aerodynamics of a subscale model of a variable pressure ratio high through flow turbine. The problem areas are small limit loading margin, high rotor relative inlet Mach number, low aspect ratio blading, large rotor turning and low hub/tip radius ratio. GRA

**N77-30122#** Aeronautical Systems Div., Wright-Patterson AFB, Ohio

**AN ATTEMPT TO CORRELATE NORMAL VORTICITIES WITH TOTAL PRESSURE DISTORTION PATTERNS AT THE ENTRANCE TO A GAS TURBINE ENGINE** Final Report, Jun 1974 - Aug 1976

Stephen M Clark Feb 1977 89 p refs

(AD-A040370, ASD-TR-76-34) Avail NTIS HC A05/MF A01 CSCL 21/5

An attempt is made to predict the worst-case pressure distortion produced by a distortion screen at the entrance to a gas turbine engine using only steady-state total pressure measurements. The vector sum of radial and circumferential vorticity, called normal vorticity, is compared to both the difference between steady-state and worst-case distortion patterns, and the standard deviation of the high response pressure measurements called turbulence. Average values of turbulence and vorticity are found to be unrelated to the increase in distortion between steady-state and worst-case pressure measurements. Probe-by-probe analysis of the data indicates that a correlation may exist between vorticity and the distortion increase. Although a final prediction technique is not developed, an improved test program and refined data analysis techniques are outlined.

Author (GRA)

**N77-30124#** Naval Research Lab, Washington, D C  
**QUANTITATIVE TLC ANALYSIS OF AMINE ANTIOXIDANTS IN HIGH-TEMPERATURE JET ENGINE LUBRICANTS**

Paul J Sniegowski Apr 1977 9 p refs

(AD-A039909, NRL-MR-3490) Avail NTIS HC A02/MF A01 CSCL 11/8

A quantitative thin-layer chromatography (TLC) method with a relative standard deviation of four percent is described for the analysis of commonly used amine antioxidants in high-temperature jet engine lubricants. The method is convenient in that after development of the plates, the components develop characteristic visible colors suitable for analysis. Author (GRA)

**N77-30125#** Naval Air Engineering Center, Lakehurst, N J  
Ground Support Equipment Dept

**NON-INTEGRATED GAS TURBINE ENGINE DIAGNOSTICS  
TRADEOFF ANALYSIS Final Technical Report, Jul 1976 -  
Jul. 1976**

H C MacLaughlin 10 May 1977 93 p refs  
(AD-A039494, NAEC-GSED-100) Avail NTIS  
HC A05/MF A01 CSCL 21/5

Diagnostic equipment and techniques to be included in a non-integrated system to detect and isolate the four most prevalent malfunctions in Navy aircraft gas turbine engines were selected. Each of twenty-five candidate elements were considered on the basis of technical feasibility, cost-effectiveness and diagnostic need. Gas path analysis, with trending, and borescope inspection were selected as the most effective methods to diagnose the leading engine malfunctions (63%), foreign object damage and hot section distress. Other elements to be included in the proposed embryonic system are called oil analysis, time temperature recording indicator/low cycle fatigue counters vibration testers trim testers test system vibration equipment, vibration signal analysis equipment, temperature sensing system tester, and Jetcal Analyzer. Oil analysis techniques being developed indicate a significant improvement compared to spectrometric analysis of diagnostic purposes. A summary of specific elements for utilization at each of three levels of maintenance and an engineering development plan with proposed implementation milestones are included. Author (GRA)

**N77-30126#** Air Force Inst of Tech, Wright-Patterson AFB, Ohio School of Engineering

**PARAMETRIC PERFORMANCE EVALUATION OF A JET  
ENGINE DERIVED FROM A TURBOCHARGER  
M S. Thesis**

Richard B Brown Mar 1977 119 p  
(AD-A039116, AFIT/GAE/AE/76D-2) Avail NTIS  
HC A06/MF A01 CSCL 21/5

Previous conceptual studies have shown that it is feasible to construct a low-thrust, jet engine, based on a production turbocharger at relatively low cost. A parametric evaluation was performed on a turbojet engine derived from an AiResearch 15 lb(m)/sec airflow turbocharger unit to determine its static performance characteristics and the maximum attainable thrust without augmentation or major component modification. The performance of various turbine housing/nozzle combinations was measured in steady state operation using a much improved instrumentation system, together with various system improvements. Parameters were measured on a common time base and plotted to depict the total performance of the unit over its usable range. Maximum thrust obtained was 97 lb(f), exceeding the initially predicted theoretical value of 67 lb(f) by 45%. Data was reduced to coded 3 digit numbers for programming and plotting using the CDC 6600 computer. The results were machine plots depicting the performance characteristics of the unaugmented engine for use in further studies including augmentation. In addition, computer performance programs for coded raw data were written for future data reduction and analysis. Author (GRA)

**N77-30128** Purdue Univ, Lafayette Ind  
**EFFECTS OF CONTROL LAWS AND RELAXED STATIC  
STABILITY ON VERTICAL RIDE QUALITY OF FLEXIBLE  
AIRCRAFT Ph D Thesis**

Philip Arnold Roberts 1976 112 p  
Avail Univ Microfilms Order No 77-7522

Ride quality is shown to be relatively invariant under various popular control laws. Handling quality variations are shown to be major contributors to ride quality variations on both vehicles. Relaxed static stability is artificially implemented on the study vehicles to investigate its effects on ride quality. The B-52H ride quality is generally degraded when handling characteristics are automatically restored by a feedback control to the original values from relaxed stability conditions. The B-1 shows little ride quality sensitivity to the same analysis due to the small rigid body contribution to load factors at the flight condition investigated. Dissert Abstr

**N77-30129\*#** National Aeronautics and Space Administration  
Ames Research Center, Moffett Field Calif

**ESTIMATES OF THE EFFECTIVENESS OF AUTOMATIC  
CONTROL IN ALLEVIATING WAKE VORTEX INDUCED ROLL  
EXCURSIONS**

Bruce E Tinling Aug 1977 15 p  
(NASA-TM-73267 A-7127) Avail NTIS HC A02/MF A01  
CSCL 01C

Estimates of the effectiveness of a model following type control system in reducing the roll excursion due to a wake vortex encounter were obtained from single degree of freedom computations with inputs derived from the results of wind tunnel, flight and simulation experiments. The analysis indicates that the control power commanded by the automatic system must be roughly equal to the vortex induced roll acceleration if effective limiting of the maximum bank angle is to be achieved. Author

**N77-30132\*#** Systems Technology Inc, Hawthorne, Calif  
**DEVELOPMENT OF AN INTEGRATED CONFIGURATION  
MANAGEMENT/FLIGHT DIRECTOR SYSTEM FOR PILOTED  
STOL APPROACHES Final Report**

Roger H Hoh, Richard H Klein, and Walter A Johnson  
Washington NASA Aug 1977 90 p refs  
(Contract NAS2-6441)  
(NASA-CR-2883 TR-1015-4) Avail NTIS HC A05/MF A01  
CSCL 01C

A system analysis method for the development of an integrated configuration management/flight director system for IFR STOL approaches is presented. Curved descending decelerating approach trajectories are considered. Considerable emphasis is placed on satisfying the pilot centered requirements (acceptable workload) as well as the usual guidance and control requirements (acceptable performance). The Augmentor Wing Jet STOL Research Aircraft was utilized to allow illustration by example and to validate the analysis procedure via manned simulation. Author

**N77-30134#** Texas Univ, Austin Dept of Aerospace  
Engineering and Engineering Mechanics  
**WIND TUNNEL EXPERIMENTS ON AN ACTIVELY CON-  
TROLLED, VARIABLE GEOMETRY FLUTTER MODEL  
Final Report, 1 Feb 1976 - 31 Jan 1977**

Jeff Long Mar 1977 109 p refs  
(Contract F44620-76-C-0072)  
(AD-A039216, AFOSR-77-0638TR) Avail NTIS  
HC A06/MF A01 CSCL 20/4

A reduction in flutter margin can occur for variable geometry aircraft when the wing of the aircraft is swept into the vicinity of the tail. Experiments on an aeroelastic wind tunnel model with active aerodynamic controls demonstrated that the flutter margins of these configurations can be increased through techniques other than the standard structural modifications. Improved margins were attained experimentally by employing rapidly responding aerodynamic controls activated by an optimal feedback. Author (GRA)

**N77-30135#** Toronto Univ (Ontario) Inst for Aerospace  
Studies

**A LABORATORY INVESTIGATION INTO FLIGHT PATH  
PERTURBATIONS DURING STEEP DESCENTS OF V/STOL  
AIRCRAFT Final Report, Sep 1972 - Jun 1976**

L D Reid, B Etkin, H W Tennesen, and P C Hughes  
Wright-Patterson AFB Ohio AFFDL Aug 1976 401 p refs  
Sponsored in part by the Natl Res Council of Canada  
(Contract F33615-73-C-3013, AF Proj 8219)  
(AD-A040101, AFFDL-TR-76-84) Avail NTIS  
HC A18/MF A01 CSCL 01/2

A study into the prediction of V/STOL aircraft flight path perturbations during steep landing approaches is presented. A discussion of possible approaches to the problem is reviewed. The fixed probe approach, where two point space/time correlations are measured in a boundary layer wind tunnel along the glide slope is derived in detail. A second in the moving probe approach is which a suitable three component velocity probe is moved along the glide slope in a boundary layer wind tunnel and the

time history of the resulting measurements used to determine the response of the aircraft. A candidate moving probe apparatus is analyzed and its feasibility evaluated. Two similar boundary layer wind tunnels are used to generate simulations of the planetary shear layer. The properties of the 8 x 8 in tunnel are described along with the associated instrumentation. Author

**N77-30136#** Advisory Group for Aerospace Research and Development Paris (France)

**A STUDY OF STANDARDIZATION METHODS FOR DIGITAL GUIDANCE AND CONTROL SYSTEMS**

May 1977 548 p refs

(AGARD-AR-90, ISBN-92-835-1244-8) Avail NTIS HC A23/MF A01

Standardization methods for digital guidance and control systems are examined, particularly with regard to data transmission techniques and high level programming languages. Discussion of the general problems and techniques is included as well as reports on the particular experiences of the individual nations. Annexes contain full details of the techniques studied and include comparisons of data transmission methods and high level languages. These comparisons are designed to outline the relevant features of the different techniques. Author

**N77-30180\*#** Boeing Commercial Airplane Co., Seattle Wash  
**DESIGN AND FABRICATION OF GRAPHITE-EPOXY BOLTED WING SKIN SPLICE SPECIMENS Technical Report, Feb 1976 - May 1977**

R W Johnson and J E McCarty May 1977 54 p refs  
(Contract NAS1-14327)

(NASA-CR-145216 D6-44503) Avail NTIS HC A04/MF A01 CSCL 11D

Graphite-epoxy bolted joint specimens were designed and fabricated. These specimens were to be representative of a side-of-body wing skin splice with a 20-year life expectancy in a commercial transport environment. Preliminary tests were performed to determine design values of bearing and net tension stresses. Based upon the information developed a three-fastener-wide representative wing skin splice was designed for a load of 2627 KN/m (15 000 lbf/in). One joint specimen was fabricated and tested at NASA. The wing skin splice failed at 106 percent of design ultimate load. This joint design achieved all static load objectives. Fabrication of six specimens together with their loading fixtures was completed and the specimens were delivered to NASA-LRC. Author

**N77-30221#** Aeronautical Research Council, London (England)  
Structures Dept

**EFFECT OF INTERSPERSED PERIODS OF HEATING ON FATIGUE CRACK INITIATION AND PROPAGATION IN CMOO1 (RR58) CLAD SHEET**

F E Kiddle Jul 1976 33 p refs Supersedes RAE-TR-76092 and ARC-37041

(AD-A041014 ARC-CP-1366 RAE-TR-76092 ARC-37041) Avail NTIS HC A03/MF A01 CSCL 11/6

Fatigue tests have been conducted to study the effect of interspersed periods of heating on the initiation and early growth of cracks from holes in clad sheet and also on later stages of crack propagation. The tests were under flight simulation loading and the material was CMOO1 (RR58) clad aluminium alloy sheet. Interspersed heating reduced the lives to initiate and grow cracks to 2mm and this is attributed to the softening of strain hardened material at the crack tip, but no effect was observed for longer crack lengths. When load was applied during the periods of heating creep redistribution of local stress retarded the growth of short and long cracks. Further work is underway to investigate fatigue-heat interactions under different load-temperature sequences, other forms of material and over a wider range of crack lengths. Author (GRA)

**N77-30249#** Boeing Commercial Airplane Co Seattle, Wash  
**EXPLORATORY OF DEVELOPMENT OF DURABILITY OF ADHESIVE BONDED JOINTS Final Report, 1 Feb 1974 - Oct. 1976**

J A Marceau and J C McMillan Oct 1976 160 p refs  
(Contract F33615-74-C-5065 AF Proj 7381)  
(AD-A039864, D6-41317-2, AFML-TR-76-173) Avail NTIS HC A08/MF A01 CSCL 11/4

The objectives of the program were to evaluate stressed durability test methods to use these methods to test adhesive bonding materials and processes and to develop a correlation between laboratory test results and in-service performance. The test method evaluation was completed early in the program and results were published in an interim technical report AFML-TR-75-3, Durability of Adhesive Bonded Joints February 1975. Four stressed durability test methods were selected for the test program: (1) A thick-adherend lap-shear specimen (Mode I and Mode II loading), (2) A thick-adherend double cantilever beam (DCB) specimen (Mode I loading), (3) A thin adherend DCB specimen (wedge test, Mode I loading) and (4) A thick adherend single cantilever beam (SCB) specimen for honeycomb sandwich evaluation (Mode I and Mode II loading). Alloy adherend surface treatment adhesive primer and adhesive interactions were evaluated. The materials and processes used were: (1) Alloys 2024-T3 2024-T3 clad (1230 alloy) 7075-T6, and 7075-T6 clad (7072 alloy) (2) Adhesives FM 123-2 and EA 9628 250 F curing adhesives and AF 143 and PL 729-3 350 F curing adhesives (3) Primers BR 123 non-corrosion-inhibiting primer, BR 127 corrosion-inhibiting primer, and EC 3917 and PL 728 corrosion-inhibiting primers for use with the two 350 F curing adhesives, (4) Adherend surface treatment processes Optimized FPL etch, chromic acid anodize and phosphoric acid anodize and (5) Aluminum honeycomb core Standard core, Dura-Core and CR III corrosion-resistant cores and phosphoric acid anodized core. GRA

**N77-30261#** RAND Corp., Santa Monica, Calif  
**THE POTENTIAL ROLE OF TECHNOLOGICAL MODIFICATIONS AND ALTERNATIVE FUELS IN ALLEVIATING AIR FORCE ENERGY PROBLEMS Interim Report**

J R Gebman, W L Stanley, J P Weyant, and W T Mikolowsky Dec 1976 170 p refs

(Contract F49620-77-C-0023)  
(AD-A039597, R-1829-PR) Avail NTIS HC A08/MF A01 CSCL 21/4

This report examines short- and long-term measures to reduce the consumption of petroleum jet fuels by the Air Force. Engine retrofits and aerodynamic modifications to existing aircraft can save significant quantities of jet fuel, however savings in fuel expenditures are not enough to offset high initial costs of engine retrofits. If accomplished early in an aircraft's life cycle, relatively lower costs of modest aerodynamic modifications may be recoverable through savings in fuel expenditures. Synthetic JP fuels derived from oil shale or coal appear to be the most attractive future alternatives to petroleum jet fuels. If the foreign oil cartel maintains its price-setting effectiveness and synthetic fuels industry develops in the United States, development of an Air Force capability to interchangeably use fuels derived from crude oil, oil shale or coal could be economically attractive and enhance the Air Force's position in the jet fuel marketplace. Author (GRA)

**N77-30301#** Naval Ship Research and Development Center  
Bethesda, Md Aviation and Surface Effects Dept

**PERFORMANCE PREDICTION METHOD FOR A WING-IN-GROUND EFFECT VEHICLE WITH BLOWING UNDER THE WING Final Report, Sep 1976 - Mar 1977**

David G Rousseau and Roger W Gallington Mar 1977 37 p refs

(AD-A039829 DTNSRDC/ASED-379) Avail NTIS HC A03/MF A01 CSCL 01/3

Recent efforts in theoretical analysis and experimental observations have moved the concept of power-augmented flight in ground effect toward practicality. With the addition of lift and drag due to external airflow end-plate leakage, water skin friction, wave drag effects and wave clearance constraints a flow model can be made capable of effective comments. The analysis shows that there are wave drag and wave clearance

related limits to many aspects of the vehicle configuration. The most important of which are cruising height and aspect ratio in that they have a very large effect on transport efficiency. Unfortunately the low flying high aspect ratio cases are ruled out due to wave impact problems. Testing of a point design vehicle arrived at through the use of analysis such as the one of this report needs to be performed as final verification of the accuracy of the design procedure. Author (GRA)

**N77-30421#** Analytical Methods Inc. Bellevue Wash  
**INVESTIGATIONS OF THREE-DIMENSIONAL FLOW SEPARATION ON FUSELAGE CONFIGURATIONS** Final Report, May 1975 - May 1976

Frank A Dvorak Brian Maskew and Frank A Woodward Mar 1977 96 p refs  
 (Contract DAAJ02-75-C-0036)  
 (AD-A039382 USAAMRDL-TR-77-4) Avail NTIS  
 HC A05/MF A01 CSCL 20/4 --

A method is described for calculating the complete pressure distribution on a body with separated flow. The boundary layer characteristics are calculated along several streamlines up to the point where separation is predicted. The separated flow is modeled by streamwise panels of uniform vorticity attached to the body near the predicted separation line. Comparisons are presented of calculated and experimental pressure distributions for a cylinder, a sphere and the B0105 fuselage. The results are in fair agreement but there are certain features of the results and restrictions of the source/vortex inviscid model which need improvement. Author (GRA)

**N77-30422#** Textron Bell Aerospace Co. Buffalo N Y  
**NUMERICAL SOLUTION OF COMPLETE FLOWS AROUND EXTERNAL STORES** Final Report, Aug 1974 - Dec 1976  
 Z Popinski W L Rushmore and S W Zelazny Dec 1976 73 p refs

(Contract F4460-75-C-0003)  
 (AD-A039213 Rept-9236-927001 AFOSR-77-0621TR) Avail  
 NTIS HC A04/MF A01 CSCL 20/4

A computer code, based on a finite element algorithm was developed to solve the governing equations for a three-dimensional flow around a spherically blunted cone at an angle of attack. The solution is valid for a boundary layer region including the flow separation in the cross-flow direction in the leeward area. The required initial and boundary conditions for this solution are obtained from a finite difference computer program for laminar compressible three-dimensional boundary layer flow. Extension of the analysis to include the turbulent transport using the mixing length theory and a two-equation turbulence model is described. The results demonstrate the capability of the finite element method to predict the three-dimensional boundary region flow with cross-flow separation in the leeward area and to model the effects of turbulent flow. Author (GRA)

**N77-30439** Pennsylvania Univ., Philadelphia  
**MICROWAVE HOLOGRAPHIC IMAGING OF AIRCRAFT WITH SPACEBORNE ILLUMINATING SOURCE**  
 Ph D Thesis

Tomislav Angel Dzekov 1976 274 p  
 Avail Univ Microfilms Order No 77-10158

The conceptual development of a method for providing high angular resolution and accurate angular position estimates for surveillance and traffic control of aircraft is reviewed. The method is based on the use of a large random array of conformally located receiving elements and a CW microwave source located on a geostationary satellite. In the vicinity of the earth's surface and above the array a roughly cylindrical volume of several hundred kilometers in diameter is illuminated. The interference pattern of the direct signal from the satellite and the signals reflected from aircraft in the illuminated volume is sampled by the array elements at discrete locations and then interrogated digitally to obtain useful target data. Dissert Abstr

**N77-30444\*#** Old Dominion Univ. Research Foundation Norfolk Va

**SENSOR FOR MEASURING INSTANTANEOUS ANGLE OF ATTACK OF HELICOPTER BLADES** Progress Report, Jul 1976 - Jul 1977

P Stephen Barna and Henry W Lu Aug 1977 47 p  
 (Grant NSG-1143)  
 (NASA-CR-154808) Avail NTIS HC A03/MF A01 CSCL 14B

Various research activities are reported in the following areas: (1) improving and testing probes; (2) theoretical studies of probe motion; and (3) improving research facilities. It is concluded that a satisfactory solution to the problem of measuring angle of attack of helicopter blades may be found in the near future. Author

**N77-30476#** Boeing Commercial Airplane Co. Renton Wash  
**AN EXTENDED PREDICTION MODEL FOR AIRPLANE BRAKING DISTANCE AND A SPECIFICATION FOR A TOTAL BRAKING PREDICTION SYSTEMS, VOLUME 2** Final Report, Aug 1975 - Dec 1976

M K Wahi, S M Warren and H H Straub Wright-Patterson AFB Ohio ASD Mar 1977 185 p  
 (Contract F33657-74-C-0129)  
 (AD-A039967 ASD-TR-77-6-Vol-2) Avail NTIS  
 HC A09/MF A01 CSCL 01/2

This report details the results from the sensitivity study portion of the Combat Traction II Phase II (Extended) Program and also contains the calculations resulting from prediction equation formulation for the B-52, KC-135 and F-111 airplanes. GRA

**N77-30480#** Sikorsky Aircraft Stratford Conn  
**THE 3000-HP ROLLER GEAR TRANSMISSION DEVELOPMENT PROGRAM VOLUME 6 RELIABILITY AND MAINTAINABILITY REPORT** Final Report

G F Gardner K R Cormier, and B Trustee Jan 1977 179 p refs  
 (Contract DAAJ02-69-C-0042 DA Proj 1G1-62207-AA-72)  
 (AD-A039381 USAAMRDL-TR-73-98F-Vol-6 UTRC/30974)  
 Avail NTIS HC A09/MF A01 CSCL 13/9

This report presents a summary of the testing conducted during the development of a 3000-HP Roller Gear Transmission. During this program a helicopter transmission using a 19.85 reduction ratio roller gear transmission was designed, manufactured and subjected to extensive testing. A reliability analysis shows that a fully developed roller gear transmission offers comparable reliability to a conventional two-stage planetary unit. However, relating the development testing of the roller gear transmission to project the reliability is premature at this stage. The analysis does show that on-condition maintenance of the roller gear transmission is feasible. A summary of the testing and development of the roller gear transmission is included. Detailed reports on the design, manufacture, and bench and aircraft testing have been published separately. Author (GRA)

**N77-30481#** Boeing Commercial Airplane Co. Seattle Wash  
**THE 3-D STRESS ANALYSIS OF A TURBINE BLADES** Final Report

C M Lewis R A Samuel and F Yen Mar 1977 86 p  
 (Contract DAAG46-75-C-0072)  
 (AD-A039176 D6-42735, AMMRC-CTR-77-14) Avail NTIS  
 HC A05/MF A01 CSCL 21/5

This report presents a demonstration of the usefulness of the ATLAS system in performing three-dimensional elastic stress analysis of a turbine blade. Modeling details for a shrouded uncooled turbine blade are outlined and program execution and data management techniques are discussed. GRA

**N77-30905\*#** Bolt Beranek and Newman Inc Canoga Park Calif

**COHERENCE AND PHASE TECHNIQUES APPLIED TO NOISE DIAGNOSIS IN THE NASA AMES 7 TIMES 10-FOOT WIND TUNNEL NO 1**

J F Wilby A G Piersol P E Rentz and T D Scharton 18 Jul 1977 62 p refs  
(Contract NAS2-8382)  
(NASA-CR-152039, BBN-3559) Avail NTIS HC A04/MF A01 CSCL 20A

Measurements have been made of coherence and phase spectra for the acoustic field in a subsonic wind tunnel The data are interpreted in terms of simple analytical models for propagating and diffuse noise fields including the presence of uncorrelated noise signals It is found that low frequency noise propagates upstream and downstream from the fan with the noise in the test section arriving in the upstream direction High frequency sound is generated in the test section and propagates upstream and downstream In the low frequency range the ratio of diffuse to propagating energy is about eight for all locations in the test section diffuser and settling chamber the value of the ratio increases with frequency Author

**N77-30906\*#** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

**ACCURACY OF THE KIRCHOFF FORMULA IN DETERMINING ACOUSTIC SHIELDING WITH THE USE OF A FLAT PLATE**

Ralph E Gabrielsen and Joseph E Davis Aug 1977 20 p refs Prepared in cooperation with US Army Air Mobility Res and Develop Lab Moffett Field Calif  
(NASA-TM-73261 A-7111) Avail NTIS HC A02/MF A01 CSCL 20A

It has been suggested that if jet engines of aircraft were placed at above the wing instead of below it the wing would provide a partial shielding of the noise generated by the engines relative to observers on the ground The shielding effects of an idealized three-dimensional barrier in the presence of an idealized engine noise source was predicted by the Kirchhoff formula Based on the good agreement between experimental measurements and the numerical results of the current study, it was concluded that the Kirchhoff approximation provides a good qualitative estimate of the acoustic shielding of a point source by a rectangular flat plate for measurements taken in the far field of the flat plate at frequencies ranging from 1 kHz to 20 kHz At frequencies greater than 4 kHz the Kirchhoff approximation provides accurate quantitative predictions of acoustic shielding Author

**N77-30922#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany)

**THE CALCULATION OF FLOW FIELDS ABOUT THREE DIMENSIONAL BODIES IN HIGH ALTITUDE (FREE-MOLECULAR FLOW OF NEUTRAL ATOMS)**

Walter Wuest 26 May 1975 69 p refs In GERMAN ENGLISH summary Translation was announced as N76-27969  
(DLR-FB-75-45) Avail NTIS HC A04/MF A01 DFVLR Goettingen DM 32 30

On bodies with single molecular reflection (plane walls or surfaces with convex curvature) in free molecular flow the local forces and the flow field can be calculated explicitly On bodies with multiple molecular reflection (e g surfaces with concave curvature), where from one point of the surface another one can be seen an interaction of the diffusely reflected molecules occurs which is calculated for some simple shapes Author

**N77-31005\*#** California Univ Berkeley Inst of Governmental Studies

**INTERACTIONS OF TECHNOLOGY AND SOCIETY IMPACTS OF IMPROVED AIRTRANSPORT A STUDY OF AIRPORTS AT THE GRASS ROOTS**

Todd LaPorte Stephen Rosenthal, Stuart Ross, Kai N Lee and Edith Levine Washington NASA Jul 1977 396 p refs  
(Grant NGR-05-003-471)  
(NASA-CR-2871) Avail NTIS HC A17/MF A01 CSCL 01E

The feasibility of applying a particular conception of technology and social change to specific examples of technological development was investigated The social and economic effects of improved airport capabilities on rural communities were examined Factors which led to the successful implementation of a plan to construct sixty small airports in Ohio are explored and implications derived for forming public policies evaluating air transportation development and assessing technology Author

**N77-31072\*#** National Aeronautics and Space Administration Langley Research Center Langley Station, Va

**A COMPARISON OF THE RESULTS OF DYNAMIC WIND-TUNNEL TESTS WITH THEORETICAL PREDICTIONS FOR AN AEROMECHANICAL GUST-ALLEVIATION SYSTEM FOR LIGHT AIRPLANES**

Eric C Stewart and L Tracy Redd Washington Sep. 1977 47 p refs  
(NASA-TN-D-8521, L-11352) Avail NTIS HC A03/MF A01 CSCL 01A

Dynamic wind tunnel tests have been conducted on a 1/6-scale model of a general aviation airplane equipped with an all-mechanical gust alleviation system which uses auxiliary aerodynamic surfaces to drive the flaps The longitudinal short period motions were studied under simulated gust conditions in order to verify the mathematical model used in a previous study to predict the performance of the full scale system and determine the amount of normal acceleration alleviation which could be attained The model responses were measured for different configurations with the system active and without the system active for comparison The tests confirmed the general relationships between the experimental variables and the model responses predicted by the mathematical model, but there were significant differences in the magnitudes of the responses The experimental results for the model were used to estimate a reduction of 30 percent in the rms normal acceleration response of a similar full scale airplane in atmospheric turbulence Author

**N77-31073#** Advisory Group for Aerospace Research and Development, Paris (France)

**UNSTEADY AIRLOADS IN SEPARATED AND TRANSONIC FLOW**

Apr 1977 273 p In ENGLISH partly in FRENCH Presented at the 44th Meeting of the AGARD Struct and Mater Panel, Lisbon, 19-20 Apr 1977  
(AGARD-CP-226, ISBN-91-835-0197-7) Avail NTIS HC A12/MF A01

The prediction and description of the separated flow environment and the essential effects of airframe response on individual aircraft components is reviewed along with flutter, aeroelastic instabilities, and other static and dynamic aeroelastic problems Analytical approaches, wind tunnel tests as well as flight test techniques are included

**N77-31074#** Hawker Siddeley Aviation Ltd, Kingston upon Thames (England)

**UNSTEADY AIRLOADS IN SEPARATED AND TRANSONIC FLOW**

C L Bore In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 9 p

Avail NTIS HC A12/MF A01

The papers dealing with unsteady loads arising from separated flow that were presented at the AGARD Fluid Dynamics Panel's symposium on Prediction of Aerodynamic loading are reviewed The principal topics discussed include dynamic phenomena arising from aircraft maneuvers transient dynamic stall loads, and methods for predicting buffet Author

**N77-31075\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

**SEPARATED-FLOW UNSTEADY PRESSURES AND FORCES ON ELASTICALLY RESPONDING STRUCTURES**

C F Coke, D W Riddle, and C Hwang (Northrop Corp, Hawthorne Calif) In AGARD Unsteady Airloads in Separated

and Transonic Flow Apr 1977 25 p refs

Avail NTIS HC A12/MF A01 CSCL 01C

Broadband rms, spectral density, and spatial correlation information that characterizes the fluctuating pressures and forces that cause aircraft buffet is presented. The main theme is to show the effects of elasticity. In order to do so, data are presented that were obtained in regions of separated flow on wings of wind-tunnel models of varying stiffness and on the wing of a full-scale aircraft. Reynolds number effects on the pressure fluctuations are also discussed. Author

**N77-31076#** General Dynamics/Fort Worth, Tex  
**PREDICTION OF TRANSONIC AIRCRAFT BUFFET RESPONSE**

Atlee M Cunningham, Jr and David B Benepa, Sr /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 21 p refs

Avail NTIS HC A12/MF A01

A method for predicting aircraft buffet response is briefly reviewed. Rigid wind tunnel model fluctuating pressure data are used to form buffet forcing functions to which airplane responses are calculated with a mathematical dynamic model of the airplane. Buffet pressure data on the wing are used to estimate fluctuating loads on the horizontal tail. By including the extremes of phasing and contributions of symmetric and antisymmetric airplane responses, predicted upper and lower bounds are established. The method is applied to a variable sweep fighter aircraft and predicted results are compared with flight test data. The types of buffeting flow considered for various wing sweep angles include separated and vortex flows as well as oscillating shocks. The current method is compared with three other methods in the correlation with flight test data. The inherent scatter of flight data is discussed as well as probable sources of the scatter. A mechanism is described by which wing torsional motion and shock oscillation couple to produce relatively severe buffeting conditions at a forward wing sweep. The importance of considering buffet fatigue damage on secondary structure is discussed. Author

**N77-31077#** Royal Aircraft Establishment, Farnborough (England) Aerodynamics Dept  
**THE DYNAMIC RESPONSE OF WINGS IN TORSION AT HIGH SUBSONIC SPEEDS**

G F Moss and D Pierce /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 21 p refs

Avail NTIS HC A12/MF A01

The structural response of aircraft wings to aerodynamic excitation at conditions appropriate to maneuvers at high subsonic speeds is discussed. Reference is made to wind tunnel experiments using models specially designed to deform under test in a realistic way as well as rigid models of conventional construction. The primary torsion mode of vibration of the wings tended to be strongly excited under some aerodynamic flow conditions on the flexible models used, and in some cases the amplitude was large and similar to single-degree-of-freedom flutter in character. Data from some flight tests is quoted to demonstrate that this type of response may well occur in practice. Author

**N77-31078#** Messerschmidt-Boelkow G m b H, Munich (West Germany)  
**EVALUATION OF VIBRATION LEVELS AT THE PILOT SEAT CAUSED BY WING FLOW SEPARATION**

J Becker and K Dau (Vereinigte Flugtechnische Werke-Fokker GmbH Bremen West Germany) /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 28 p refs

Avail NTIS HC A12/MF A01

Examples of the evaluation of vibration levels on the pilot seat are presented. The first deals with the results of low speed measurements on a strake wing model with and without flap and slats including the effect of leading edge blowing, in the incidence region  $Q$  less than or equal to  $\alpha$  less than or

equal to  $90^\circ$ . The second example demonstrates the results obtained by the method based on measurements of fluctuating pressures on rigid models for two configurations with  $25^\circ$  and  $45^\circ$  degree wing sweep in the high subsonic region ( $Q$  less than or equal to  $M$  less than or equal to  $0.85$ ). Author

**N77-31079#** Royal Aircraft Establishment, Bedford (England)  
**MEASUREMENTS OF BUFFETING ON TWO  $65^\circ$  DELTA WINGS OF DIFFERENT MATERIALS**

D C Mabey and G F Butler /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 14 p refs

Avail NTIS HC A12/MF A01

Measurements of buffeting were made on two  $65^\circ$  delta wings one made of steel and the other of magnesium. A nondimensional buffet excitation parameter was derived from measured values of the rms buffeting response and total damping ratio. The materials were selected so that the resonant frequencies of the wings were almost the same, while giving a significant variation of response and damping ratio under identical free stream conditions. The wings were tested at Mach numbers of  $0.35$ ,  $0.7$  and  $1.4$  and the Reynolds number was varied over a wide range. The results showed that the buffet excitation parameter for the first bending model was virtually identical for both wings and was independent of Reynolds number except at very low Reynolds numbers. A significant level of aerodynamic damping was measured on the magnesium wing and the experimental values agreed well with estimates made using slender wing theory. Author

**N77-31080#** British Aircraft Corp Preston (England) Military Aircraft Div

**DYNAMIC LOADING OF AIRFRAME COMPONENTS**

C G Lodge and M Ramsey /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 26 p refs

Avail NTIS HC A12/MF A01

The design of modern combat aircraft is discussed in terms of structural fatigue life. Unsteady loads due to separated flow conditions in maneuvering flight are examined. Dynamic loads on a modern variable sweep wing combat aircraft are predicted making use of wing tunnel model tests and results from flight tests. The predictions are compared with available prototype flight measurements. Author

**N77-31081#** Vereinigte Flugtechnische Werke G m b H, Bremen (West Germany)

**AIRFRAME RESPONSE TO SEPARATED FLOW ON THE SHORT HAUL AIRCRAFT VFW 614**

Helmut Zimmermann and Guenter Krenz /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 9 p refs

Avail NTIS HC A12/MF A01

Using the VFW 614 aircraft as an example the influence of an intermittent jet flow on sub-structures outside known jet boundaries is illustrated. Effects comparable to those due to the engine jet are caused also by the wake of movable wing parts such as spoilers and airbrakes. The VFW 614 is used again as an example to illustrate the occurrence of horizontal tail buffet due to flow disturbances for outside the spoiler wake region, and to describe the steps taken to eliminate this type of buffet. Several examples of flow separation with ensuing buffeting which typically occur in the course of flight trials, and measures to combat these disturbances are discussed. Author

**N77-31082#** Aeritalia S p A Torino (Italy)

**TAIL RESPONSE TO PROPELLER FLOW ON A TRANSPORT AIRPLANE**

L Chesta /in AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 13 p

Avail NTIS HC A12/MF A01

The results of a flight investigation on tail vibrations on transport aircraft and the measures taken to overcome the subsequent problems are described. Factors studied include (1)



the source of vibrations, (2) the flight conditions in which they occur, and (3) the impact of the vibration level on the fatigue life. It is concluded that the three propeller blades and the associated airscrews are the excitation source of the vibrations.  
Author

**N77-31083#** Saab-Scania Linköping (Sweden) Aerospace Div

**FLUTTER CALCULATION FOR THE VIGGEN AIRCRAFT WITH ALLOWANCE FOR LEADING EDGE VORTEX EFFECT**

In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 7 p refs

Avail NTIS HC A12/MF A01

An application in a flutter calculation for the Viggen aircraft of a program system for aeroelastic calculations is briefly described. The result which is checked against an independent calculation shows that a large flutter margin exists. For increasing angle of incidence, however, the margin may decrease due to the effect of the leading edge vortices. An estimate of the decrease was obtained by applying a correction factor based on measured pressure distributions for steady flow to the calculated lift distribution.  
Author

**N77-31084#** Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio Dynamics Lab

**A BRIEF OVERVIEW OF TRANSONIC FLUTTER PROBLEMS**

Walter J Myktyow In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 13 p refs

Avail NTIS HC A12/MF A01

A framework of industrial flutter problems with particular emphasis on the impact for the speed region is provided. Flutter stability boundaries are given re-emphasizing the critical design conditions present in the transonic flight region. The re-emphasis is accomplished using results from research flutter model tests, aircraft design and development model tests, and aircraft flight damping measurements.  
B B

**N77-31085#** National Aerospace Lab Amsterdam (Netherlands)  
**UNSTEADY AIRLOADS ON AN OSCILLATING SUPERCRITICAL AIRFOIL**

N Tijdeman P Schippers and A J Pearson In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 15 p refs

Avail NTIS HC A12/MF A01

Results are presented of unsteady pressure measurements on a two-dimensional model of the supercritical NLR 7301 airfoil performing pitching oscillations about an axis at 40 per cent of the chord.  
Author

**N77-31086#** General Dynamics/Convair San Diego, Calif  
**THE TRANSONIC OSCILLATING FLAP: A COMPARISON OF CALCULATIONS WITH EXPERIMENTS**

R Magnus and H Yoshihara (Boeing Co Seattle) In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 5 p refs Sponsored by AF

Avail NTIS HC A12/MF A01

Finite difference calculations based on the exact inviscid equations for an oscillating flap on an airfoil at  $M = 0.875$  are compared to the Tijdeman-Schippers experimental results. Viscous effects were incorporated in a phenomenological manner using viscous displacement ramps. Reasonably good agreement was obtained, but with a significant discrepancy in the shock motions attributable to a mismatch in the surface pressures upstream of the shock. Recalculation at  $M = 0.854$  yielded results in good overall agreement with the experiments at  $M = 0.875$  for both the steady and the unsteady cases.  
Author

**N77-31087\*#** National Aeronautics and Space Administration Ames Research Center Moffett Field Calif  
**EFFICIENT SOLUTION OF UNSTEADY TRANSONIC FLOWS ABOUT AIRFOILS**

W F Ballhaus and P M Goorjian (Informatics Corp, Palo Alto, Calif) In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 11 p refs Prepared in cooperation with AAMRDL

Avail NTIS HC A12/MF A01 CSCL 01A

An implicit finite difference procedure was developed for the efficient solution of unsteady transonic flow fields. Sample computations illustrate applications of procedures to aerodynamic problems. Solutions are presented that illustrate three types of shock wave motion that can result from airfoil control surface oscillations. The significant effect of wind tunnel wall conditions on these shock wave motions is demonstrated. Solutions are also presented for a simple aeroelastic problem in which the flow field equations and the structural motion equations are integrated simultaneously in time. Both stable and unstable aeroelastic interactions are considered. The procedure is adapted to compute unsteady aerodynamic force coefficients by the indicial method.  
Author

**N77-31089#** Royal Aircraft Establishment Farnborough (England) Structures Dept

**A PRACTICAL FRAMEWORK FOR THE EVALUATION OF OSCILLATORY AERODYNAMIC LOADING ON WINGS IN SUPERCRITICAL FLOW**

H C Garner In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 15 p refs

Avail NTIS HC A12/MF A01

An approximate theoretical treatment is devised in terms of nonlinear steady surface pressure and linear oscillatory loading. The steady data are taken either from transonic small perturbation theory or from static measurements of surface pressure. The resulting theoretical or semi-empirical method can take account of stream Mach number, mean incidence, mode of oscillation, frequency and amplitude. The calculations are organized into a computer program the scope and broad details of which are outlined. Its first application is in support of a wind tunnel study of a rigid half wing with freedom to rotate about a swept axis. The experiment provides measurements of steady and oscillatory pressure distributions over the range of Mach number from 0.60 to 0.86. The oscillatory results are compared with calculations from linearized theory and from the present method in its theoretical and semi-empirical forms. Like the dynamic experiments, the calculations show large differences between oscillatory chordwise load distributions under subcritical and supercritical conditions. In particular, the region surrounding a shockwave exhibits large and rapid changes in both amplitude and phase of the measured loading which are reproduced qualitatively in the calculations. The resulting generalized aerodynamic forces are found to depend significantly on the development of supercritical flow. The method should provide an economical indication of the influence of mean flow on the flutter aerodynamics in the lower transonic regime.  
Author

**N77-31090\*#** Boeing Commercial Airplane Co, Seattle Wash  
Flutter Research Group

**APPLICATION OF A FINITE DIFFERENCE METHOD TO THE ANALYSIS OF TRANSONIC FLOW OVER OSCILLATING AIRFOILS AND WINGS**

Warren H Weatherill, James D Sebastian (Boeing Computer Services Inc Seattle) and F Edwards Ehlers In AGARD Unsteady Airloads in Separated and Transonic Flow Apr 1977 13 p refs  
(Contract NAS1-14204)

Avail NTIS HC A12/MF A01 CSCL 01A

A finite difference method for solving the unsteady flow about harmonically oscillating wings is investigated. The procedure is based on separating the velocity potential into steady and unsteady parts and linearizing the resulting unsteady differential equation for small disturbances. Solutions are obtained using relaxation procedures. The means for improving the solution stability characteristics of the relaxation process are explored. A direct procedure is formulated which permits obtaining solutions for combinations of Mach number and reduced frequency for which the relaxation process has proved unstable. The pressure distribution for an aspect ratio 5 rectangular wing oscillating in pitch is presented.  
Author

**N77-31093\*** National Aeronautics and Space Administration  
Langley Research Center Langley Station, Va  
**SUBSONIC AND SUPERSONIC LONGITUDINAL STABILITY  
AND CONTROL CHARACTERISTICS OF AN AFT-TAIL  
FIGHTER CONFIGURATION WITH CAMBERED AND  
UNCAMBERED WINGS AND CAMBERED FUSELAGE**  
Samuel M Dollyhigh Sep 1977 79 p refs  
(NASA-TN-D-8472, L-11424) Avail NTIS HC A05/MF A01  
CSCL 01A

The longitudinal aerodynamic characteristics of a fighter airplane concept has been determined through an investigation over a Mach number range from 0.50 to 2.16. The configuration incorporates a cambered fuselage with a single external compression horizontal ramp inlet, a clipped arrow wing with horizontal tails, and a single vertical tail. The wing camber surface was optimized in drag due to lift and was designed to be self-trimming at Mach 1.40 and at a lift coefficient of 0.20. The fuselage was cambered to preserve the design wing loadings on the part of the theoretical wing enclosed by the fuselage. An uncambered flat wing of the same planform and thickness ratio distribution was also tested. Author

**N77-31094\*** Vought Corp., Hampton, Va  
**NONPLANAR WING LOAD-LINE AND SLENDER WING  
THEORY**

John DeYoung Washington NASA Aug 1977 78 p refs  
(Contract NAS1-13500)  
(NASA-CR-2864) Avail NTIS HC A05/MF A01 CSCL 01A

Nonplanar load line slender wing, elliptic wing, and infinite aspect ratio limit loading theories are developed. These are quasi two-dimensional theories but satisfy wing boundary conditions at all points along the nonplanar spanwise extent of the wing. These methods are applicable for generalized configurations such as the laterally nonplanar wing, multiple nonplanar wings or wing with multiple winglets of arbitrary shape. Two-dimensional theory infers simplicity which is practical when analyzing complicated configurations. The lateral spanwise distribution of angle of attack can be that due to winglet or control surface deflection, wing twist, or induced angles due to multiwings, multiwinglets, ground, walls, jet or fuselage. In quasi two-dimensional theory the induced angles due to these extra conditions are likewise determined for two-dimensional flow. Equations are developed for the normal to surface induced velocity due to a nonplanar trailing vorticity distribution. Application examples are made using these methods. Author

**N77-31099\*** Virginia Polytechnic Inst and State Univ., Blacksburg Dept of Aerospace and Ocean Engineering  
**THE FLOW ABOUT A SLENDER PROPELLER-DRIVEN BODY  
IN A TEMPERATURE STRATIFIED FLUID**  
T F Swean, Jr and J A Schetz Mar 1977 115 p refs  
(Contract N00014-75-C-0763 ARPA Order 1910 NR Proj 062-481)  
(AD-A040847 VPI-Aero-062) Avail NTIS HC A06/MF A01 CSCL 20/4

The turbulent wake produced by a stern propeller-driven body in a temperature stratified fluid is measured using thermocouples and pitot tubes of various size, a yawhead probe, a cross-wire hot wire, and a straight-wire hot wire. The velocity and thermal boundary layers on the body upstream of the propeller are also examined. Mean flow velocities, static pressure, flow angularity, and mean temperature distributions are reported at five downstream stations. The testing was conducted in a six ft by six ft subsonic wind tunnel. A significant increase in mixing rate is produced by the propeller in the region of 4.0 body diameters downstream. Temperature fluctuation is mild across the wake except in the vicinity of the propeller tips where it becomes relatively large. GRA

**N77-31100\*** Naval Ship Research and Development Center, Bethesda, Md Dept of Aviation and Surface Effects  
**HOVER EVALUATION OF CIRCULATION CONTROL HIGH  
SPEED ROTOR**

Kenneth R Reader Jun 1977 42 p refs  
(AD-A040921, AERO-1239, DTNSRDC-77-0034) Avail NTIS HC A03/MF A01 CSCL 01/3

A high-speed rotor model designated the RB-CCR (reverse blowing circulation control rotor) was evaluated in the hover mode. The model was tested as a two- and four-bladed rotor with several rotor configurations. In general the hover tests demonstrated that a good figure of merit can be obtained over a large range of collective pitch angles. A comparison of configurations at various collective angles showed a steady improvement in performance with increasing collective pitch angle. The RB-CCR model demonstrated that the high-speed rotor can hover with a zero mechanical collective pitch angle at a figure of merit of about 0.50. GRA

**N77-31104\*** Royal Aircraft Establishment, Farnborough (England) Aerodynamics Dept  
**ITERATIVE CALCULATION OF FLOW PAST A THICK  
CAMBERED WING NEAR THE GROUND**

C C L Sells London Aeron Res Council 1977 26 p refs  
Supersedes RAE-TR-76053, ARC-36856  
(ARC-CP-1370 RAE-TR-76053, ARC-36856) Avail NTIS HC A03/MF A01, HMSO £1.75 PHI

The method to compute the steady low-speed inviscid flow past a wing in free air, is extended to take account of ground effect. The basic method represents the perturbation due to the wing by iteratively computed distributions of sources and doublets on the wing chordal surface at each iteration the ground effect is represented by the images in the ground plane of these distributions, the strengths of which are calculated from the computed errors in the boundary conditions on upper and lower surfaces. For a given angle of incidence (and Mach number), several heights above the ground in succession can be treated, with some economy in computing time. Results are presented for a two-dimensional section (RAE 100) and for two variants of a wing of airbus type. Comparisons with another method for the RAE section suggest that the present method generally needs at least three iterations, and that for very accurate results at low ground heights further work on the program is needed. Author (ESA)

**N77-31105\*** Royal Aircraft Establishment Farnborough (England) Aerodynamics Dept  
**ITERATIVE DESIGN TECHNIQUES FOR THICK CAMBERED  
WINGS IN SUBCRITICAL FLOW**

C C L Sells London Aeron Res Council 1977 61 p refs  
Supersedes RAE-TR-76027, ARC-36857  
(ARC-CP-1371 RAE-TR-76027, ARC-36857) Avail NTIS HC A04/MF A01, HMSO £3. PHI

The development of computer programs to design camber and twist distribution, and in some applications thickness distributions for a wing without dihedral in steady inviscid incompressible (or subcritical) flow is described. The method for computing steady, inviscid, subcritical flow past a thick cambered wing is extended to design applications. Four problems are considered: (1) given thickness and doublet (first-order loading) distributions, (2) given thickness and upper-surface pressure distributions, (3) given loading and upper-surface pressure distributions, (4) a hybrid of (2) and (3) in which the thickness is specified everywhere except near the root and is determined near the root when the doublet distribution is constrained to exhibit spanwise invariance in that region. Convergence for the first problem is excellent. For all problems, good convergence is obtained outboard. For the single case reported of the second problem, convergence was secured near the root but cannot yet be guaranteed. Near the root, slow convergence was obtained for the third problem, rather better convergence for the fourth problem. This hybrid option is tentatively recommended. Author (ESA)

**N77-31106\*** Royal Aircraft Establishment, Farnborough (England) Aerodynamics Dept

**A WIND-TUNNEL INVESTIGATION OF THE EFFECTS OF  
FLAP SPAN AND DEFLECTION ANGLE, WING PLANFORM  
AND A BODY ON THE HIGH-LIFT PERFORMANCE OF A  
28 DEG SWEEP WING**

D A Lovell London Aeron Res Council 1977 199 p refs  
Supersedes RAE-TR-76030, ARC-36936  
(ARC-CP-1372, RAE-TR-76030, ARC-36936) Avail NTIS  
HC A09/MF A01, HMSO £8, PHI

Lift, drag and pinching moment were measured over an extensive range of configurations of the high-lift system on a wing of basic aspect ratio 8.35 and with a trailing-edge planform extension and a body added. The results were analyzed and compared with two linear-theory prediction methods. The measured increments in lift generated by the various elements of the high-lift system were lower than the predicted levels. An exploratory analysis of the drag results showed that the lift-dependent drag factor was considerably underestimated by the linear theory, particularly when the slat was deployed. The limitations of the planar vortex sheet used in the theory and the neglect of viscous effects are suggested as the principal reasons for the difference between experiment and theory. Deflection of the flap produced a load, which acted at a distance forward of the mean quarter chord of the flap, that was practically independent of incidence and flap span. The wing/body interference effect was insensitive to flap span and there was some evidence of a download being generated on the rear body when the high-lift system was deployed. The performance of the high-lift system was downgraded when the wing planform was extended in the root region and this was attributed to the greater non-uniformity of the spanwise loading. Author (ESA)

**N77-31103#** General Dynamics/Fort Worth, Tex  
**ASD ADVANCED PROGRAM RESEARCH INLET DATA ANALYSIS REPORT FOR 1/5 2-SCALE MODEL INLET TESTS**  
**Final Report, 14 Jul. 1975 - 1 Sep. 1976**  
Charles C Mann and Jack E Garner Jan 1977 90 p refs  
(Contract F33615-75-C-5289)  
(AD-A040707, ASD-TR-76-35) Avail NTIS HC A05/MF A01  
CSCL 21/5

The analysis of wind-tunnel data from tests of a 1/5 2-scale inlet research model covered was conducted. Inlet design and engine/inlet compatibility criteria are based on the F101-GE-100 engine characteristics and requirements. Detailed inlet flow-field analyses are discussed. Inlet pressure recovery distortion, and compatibility parameters are presented for a basic configuration from Mach 0.55 to Mach 2.0. Data for an alternate configuration are presented for Mach 0.55 to 1.5. A limited amount of data are also presented for other configurations that were tested. Author (GRA)

**N77-31103#** Naval Ship Research and Development Center, Bethesda, Md. Aviation and Surface Effects Dept  
**WIND TUNNEL RESULTS OF A 10-PERCENT SCALE POWERED SCAT VTOL AIRCRAFT** Interm Report, Jul. - Oct. 1976  
David G Lee and David W Lacey Mar 1977 31 p refs  
(AD-A040313, DTNSRDC/ASED-371) Avail NTIS  
HC A03/MF A01 CSCL 01/3

The low-speed aerodynamic characteristics of a 10-percent scale powered SCAT (Surveillance, Communications, ASMD Warning, and Targeting) configuration were investigated in the 8- by 10-foot subsonic north wind tunnel. Force and moment data were obtained for both powered and unpowered VTOL, fixed-wing aircraft. Analysis of the data indicate that the configuration is statically stable in both pitch and yaw and that control is adequate for both axes. The addition of a large aft-mounted radome did not significantly change longitudinal characteristics, but did increase lateral-directional stability. Two wings of different airfoil sections were evaluated: a NACA design and a Liebeck design. The Liebeck wing section increased lift over that generated by the NACA baseline wing section. Author (GRA)

**N77-31110#** Frost Engineering Development Corp., Englewood, Colo  
**DESIGN AND EVALUATION METHODS FOR OPTIMIZING EJECTION SEAT CUSHIONS FOR COMFORT AND SAFETY**  
**Final Report, Jul 1967 - Jun 1968**

Ernest L Stech Feb 1977 134 p refs  
(Contract F33615-67-C-1912, AF Proj 7231)  
(AD-A036035, AMRL-TR-68-126, Rept-338-7) Avail NTIS  
HC A07/MF A01 CSCL 01/3

Two kinds of cushions, passive and inflatable, were developed using analytic and empirical optimization procedures to enhance both comfort and safety. Comfort tests were run on a series of polyurethane foams, an inflatable seat cushion, and two operational seat cushions. Load-deflection and damping coefficient data were also obtained. Results of the tests showed that comfort increases as cushion thickness or inflation pressure increases. Analog computer results using a single-degree-of-freedom model of the human body demonstrated an increasing overshoot with increasing thickness or inflation pressure except for low density polyurethane foam. Optimization curves for comfort versus dynamic overshoot were generated and used in the design of the optimized cushions. GRA

**N77-31111#** Army Test and Evaluation Command Aberdeen Proving Ground Md  
**SAFETY (AVIATION MATERIAL) Final Report**  
9 Dec 1976 52 p Supersedes Report no MTP-7-3-5  
(AD-A041021 TOP-7-3-506) Avail NTIS HC A04/MF A01  
CSCL 01/3

The document identifies existing test methodology and techniques necessary to determine the degree to which aviation material meets the safety requirements stated in the requirements documents. These procedures cover the requirements aircraft armament, airframe, ejection seat, electronic, mechanical and miscellaneous hazards relating to Army aircraft. A guide for laser safety is included for use when lasers are mounted in Army aircraft. Author (GRA)

**N77-31112#** National Transportation Safety Board Washington, D C Bureau of Technology  
**US AIR CARRIER ACCIDENTS INVOLVING FIRE, 1965 THROUGH 1974 AND FACTORS AFFECTING THE STATISTICS**

17 Feb 1977 64 p refs  
(PB-266883/8, NTSB-AAS-77-1) Avail NTIS  
HC A04/MF A01 CSCL 01B

Statistical data on U S air carrier accidents involving fire from 1965 through 1974 are compared with similar data for the preceding decade. While fire still occurs in about 20 percent of the accidents in scheduled passenger operations, the ratio of fatalities from all causes to exposed occupants declined 65 percent in this study period and the ratio of fatalities from the effects of fire and smoke to exposed occupants declined 37 percent. The almost exclusive use in this study period of turbojet-powered aircraft, their improved reliability, and the use of kerosene-type fuel are factors influencing the statistics. GRA

**N77-31113#** Taussig Associates Canaan, N H  
**BRITISH AIRWAYS AN ANALYSIS OF EFFICIENCY AND COST LEVELS** Final Report  
William M Taussig May 1977 68 p  
(Contract DOT-OST-PS-70292)  
(PB-268060/1, OST-PS-70292) Avail NTIS  
HC A04/MF A01 CSCL 01B

The cost and efficiency data publicly available for British Airways is summarized and used to develop comparisons with U S air carriers. GRA

**N77-31114#** National Transportation Safety Board Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS INVOLVING AERIAL APPLICATION OPERATIONS, U S GENERAL AVIATION 1976** Accident Report  
1975 292 p  
(PB-267654/2, NTSB-AMM-77-11) Avail NTIS  
HC A13/MF A01 CSCL 01B

Facts, conditions, circumstances and probable causes are given for 429 general aviation aerial application accidents occurring in 1975. Additional statistical information is tabulated by type of accident, phase of operation, injury index, aircraft damage, pilot certificate, injuries and causal factor(s). GRA

**N77-31115#** National Transportation Safety Board, Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS INVOLVING AMATEUR/HOME BUILT AIRCRAFT, US GENERAL AVIATION, 1975**  
 1975 74 p

(PB-267652/6, NTSB-AMM-77-9) Avail NTIS  
 HC A04/MF A01 CSCL 01B

Reports of U S general aviation accidents involving amateur/home built aircraft occurring in 1975 are presented Included are 114 accident briefs, 23 of which involve fatal accidents The facts, conditions, circumstances and probable cause(s) factor(s) for each accident are given Additional statistical information is tabulated by type of accident, phase of operation injury index, aircraft damage, pilot certificate injuries and causal/factor(s)

GRA

**N77-31116#** National Transportation Safety Board, Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS, INVOLVING CORPORATE/EXECUTIVE AIRCRAFT, US GENERAL AVIATION, 1975**  
 1975 55 p

(PB-267651/8, NTSB-AMM-77-8) Avail NTIS  
 HC A04/MF A01 CSCL 01B

General aviation corporate/executive aircraft accidents occurring in the US in 1975 are reported Included are 63 accident briefs, 17 of which involve fatal accidents The brief format presents the facts, conditions, circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation, injuries and causal/factors(s)

GRA

**N77-31117#** National Transportation Safety Board, Washington, D C Bureau of Technology  
**BRIEFS AND ACCIDENTS INVOLVING MISSING AND MISSING LATER RECOVERED AIRCRAFT, US GENERAL AVIATION, 1975**  
 1975 111 p

(PB-267650/0, NTSB-AMM-77-7) Avail NTIS  
 HC A06/MF A01 CSCL 01B

One hundred twenty-nine general aviation missing and missing later recovered accidents occurring in the US in 1975 are reported Each brief presents the facts conditions, circumstances, and probable cause(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation injury index, aircraft damage, pilot certificate injuries and causal factor(s)

GRA

**N77-31118#** National Transportation Safety Board, Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS INVOLVING ALCOHOL AS A CAUSE/FACTOR, US GENERAL AVIATION, 1975**  
 11 Feb 1977 44 p

(PB-267649/2, NTSB-AMM-77-6) Avail NTIS  
 HC A03/MF A01 CSCL 01B

A publication containing reports on all U S general aviation accidents occurring in 1975, involving alcohol impairment as a cause/factor is reviewed Included are 49 accident briefs, 42 of which involve fatal accidents The brief format presents the facts conditions, circumstances and probable cause(s)/factor(s) for each accident Additional statistical information is tabulated by type of accident phase of operation, injury index aircraft damage, pilot certificate, injuries and causal factor(s)

GRA

**N77-31119#** National Transportation Safety Board Washington, D C Bureau of Technology  
**BRIEFS OF FATAL ACCIDENTS INVOLVING WEATHER AS A CAUSE/FACTOR, US GENERAL AVIATION 1975,**  
 1975 303 p

(PB-267648/4 NTSB-AMM-77-5) Avail NTIS  
 HC A14/MF A01 CSCL 01B

Reports of 283 fatal U S general aviation accidents involving weather as a cause/factor for the year of 1975 are summarized showing the facts, conditions circumstances, and probable cause(s) for each accident Additional statistical information is tabulated on all accidents involving weather as a cause/factor

by type of accident phase of operation, injury index, aircraft damage, pilots certificate, injuries and cause/factor(s) GRA

**N77-31120#** National Transportation Safety Board, Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS INVOLVING ROTORCRAFT US GENERAL AVIATION, 1975**  
 1975 173 p

(PB-267647/6, NTSB-AMM-77-4) Avail NTIS  
 HC A08/MF A01 CSCL 01B

Accidents occurring in 1975 involving U S general aviation rotorcraft are reported Included are 309 accident briefs, 26 of which involve fatal accidents The brief format presents the facts, conditions, circumstances, and probable cause(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation, injury index, aircraft damage, pilot certificate, injuries and causal factor(s)

GRA

**N77-31121#** National Transportation Safety Board Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS INVOLVING TURBINE POWERED AIRCRAFT, US GENERAL AVIATION, 1975**  
 1975 76 p

(PB-267646/8, NTSB-AMM-77-3) Avail NTIS  
 HC A05/MF A01 CSCL 01B

A publication containing reports of U S general aviation turbine powered aircraft accidents occurring in 1975 is reviewed Included are 110 accident briefs, 26 of which involve fatal accidents The brief format presents the facts conditions, circumstances and probable cause(s) for each accident Additional statistical information is tabulated by type of accident, phase of operation, injury index, aircraft damage, pilot certificate, injuries and cause/factor(s)

GRA

**N77-31122#** National Transportation Safety Board Washington, D C Bureau of Technology  
**BRIEFS OF ACCIDENTS INVOLVING MIDAIR COLLISIONS, US GENERAL AVIATION, 1975**  
 1975 48 p

(PB-267645/0, NTSB-AMM-77-2) Avail NTIS  
 HC A03/MF A01 CSCL 01B

A publication containing reports of U S general aviation midair collision accidents occurring in 1975 is reviewed Included are 29 accident files 13 of which involve fatal accidents The brief format presents the facts, conditions circumstances, and probable cause(s) for each accident Additional statistical information is tabulated by kind of flying, phase of operation, injury index, aircraft damage, pilot certificate, injuries and causal factor(s)

GRA

**N77-31123#** National Transportation Safety Board, Washington, D C Bureau of Technology  
**LISTINGS OF ACCIDENTS/INCIDENTS BY AIRCRAFT MAKE AND MODEL, US CIVIL AVIATION, 1975**  
 1975 198 p

(PB-267644/3 NTSB-AMM-77-1) Avail NTIS  
 HC A09/MF A01 CSCL 01B

A publication containing a listing of all U S civil aviation accidents/incidents occurring in calendar year 1975 sorted by aircraft make and model is reviewed Included are the file number, aircraft registration number, date and location of the accident, aircraft make and model and injury index for all 4 431 accidents/incidents occurring in the period

ERA

**N77-31124#** National Aviation Facilities Experimental Center, Atlantic City, N J  
**AIR TRAFFIC CONTROL EXPERIMENTATION AND EVALUATION WITH THE NASA ATS-6 SATELLITE. VOLUME 2 DEMONSTRATION OF SATELLITE-SUPPORTED COMMUNICATIONS AND SURVEILLANCE FOR OCEANIC AIR TRAFFIC CONTROL Final Report, Sep 1974 - Apr 1975**

Francis W Jefferson Apr 1976 88 p refs

(FAA-NA-75-64-Vol-2 FAA-RD-75-1732-Vol-2) Avail NTIS HC A05/MF A01 CSCL 17/7

Demonstrations of satellite supported communications for application to oceanic air traffic control were conducted as part of an international ATS 6 L-band satellite test program Voice data and dependent surveillance communications between air traffic controllers at a ground terminal and pseudopilots in two airborne aircraft were performed via the ATS 6 satellite and ground station A simulated aircraft terminal was also employed Each terminal provided up to six simulated data link aircraft, through computer software, for traffic loading purposes Dependent surveillance was demonstrated through data link automatic aircraft position reports Position data were obtained from an inertial navigation system and an Omega navigation system in the aircraft Independent surveillance was demonstrated using the NASA PLACE system and the ATS 6 and ATS 5 satellites Author

**N77-31125\*** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

**A DESCRIPTION OF THE SOFTWARE ANALYSIS FROM FLIGHT AND SIMULATION DATA OF THE COURSE CUT LIMITER IN THE TCV B-737 AREA NAVIGATION COMPUTER**

Charles E Knox and David A Hinton Aug 1977 21 p refs (NASA-TM-74061) Avail NTIS HC A02/MF A01 CSCL 17G

During automatic horizontal path captures, the (Terminal Configured Vehicle) B-737 airplane maintained smaller than designed path intercept angles and experienced a sawtooth bank angle oscillation during its turn towards the path From flight data it was determined that these anomalies were caused by the improper output of the course cut limiter in the horizontal path control law The output from the course cut limiter did not obtain its full value and it was calculated stepwise discontinuously The automatic horizontal path captures were then conducted on the TCV B-737 airplane real-time simulation The path intercept angles were maintained properly and no bank angle oscillation was encountered Data showed that the course cut limiter was calculated at its full value in a continuous manner The intermediate calculations of the course cut limiter in the airplane's navigation computer were rewritten and rescaled in such a manner that truncation errors could be minimized The horizontal path capture tests were then reflight The airplane maintained the proper path intercept angle and no bank angle oscillations occurred on any of the tests Author

**N77-31126\*** Stanford Research Inst Menlo Park, Calif  
**DEFINITION OF A DATA COLLECTION SYSTEM FOR US ARMY TACTICAL MICROWAVE LANDING SYSTEM EVALUATION Final Report, Mar - Sep 1976**

J H Friedigkeit and P G Stoltz Sep 1976 65 p  
(Contract DAAB07-75-C-0906)  
(AD-A041230, SRI-4462-Suppl ECOM-75-0906-SF) Avail NTIS HC A04/MF A01 CSCL 01/2

The data to be collected for flight test performance evaluation of Tactical Microwave Landing System (TMLS) by the Army is defined Data rates, data formats, and data processing requirements are developed Data recording options are considered and a preliminary design for a TMLS airborne data collection system is presented GRA

**N77-31127\*** Naval Research Lab, Washington, D C  
**A SIMPLE CLOSED-FORM SOLUTION OF A POSITION-FIXING PROBLEM Intern Report**

Ben H Cantrell 15 Apr 1977 10 p  
(AD-A039303 NRL-8115) Avail NTIS HC A02/MF A01 CSCL 17/7

A closed-form solution was obtained for the problem of finding an object's location given ranges to four stations of known location The method is simple, involving only simple algebra such as addition and multiplication and the evaluation of a few trigonometric functions Only three stations are required for the solution if some other a priori information is available such as height above the earth or the azimuth Author (GRA)

**N77-31130\*** National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif

**ACOUSTICALLY SWEEPED ROTOR Patent Application**

Fredric H Schmitz (Army Air Mobility R and D Lab Moffett Field Calif) Donald A Boxwell (Army Air Mobility R and D Lab Moffett Field Calif) and C Rande Vause, inventors (to NASA) (Army Air Mobility R and D Lab, Moffett Field, Calif) Filed 8 Sep 1977 36 p Sponsored by NASA  
(NASA-Case-ARC-11106-1, US-Patent-Appl-SN-831633) Avail NTIS HC A03/MF A01 CSCL 20A

Impulsive noise reduction is provided in a rotor blade by acoustically sweeping the chord line from root to tip so that the acoustic radiation resulting from the summation of potential singularities used to model the flow about the blade tend to cancel for all times at an observation point in the acoustic far field NASA

**N77-31131\*** National Aeronautics and Space Administration Lyndon B Johnson Space Center, Houston Tex

**SURFACE FINISHING Patent Application**

Jack A Kinzler James T Heffernan, Leroy G Fehrenkamp, inventors (to NASA) and William S Lee Filed 6 Apr 1977 26 p  
(NASA-Case-MS-C-12631-2, US-Patent-Appl-SN-785279) Avail NTIS HC A03/MF A01 CSCL 01C

An airfoil configuration and manufacturing process is described for reducing or eliminating air turbulence created by surface irregularities in the metal due to rivets wrinkles butt-joints, and the like An article adapted for relative motion with a fluid environment is finished by coating the surface with a fluid adhesive, covering the adhesive with a sheet of flexible film material under tension and setting the adhesive while maintaining tension on the film material so that the tensioned film material is bonded to the surface by the adhesive NASA

**N77-31133\*** Princeton Univ, N J  
**AN IN-FLIGHT SIMULATION OF APPROACH AND LANDING OF A STOL TRANSPORT WITH ADVERSE GROUND EFFECT Final Report**

David R Ellis [1976] 58 p refs  
(Contract NAS1-11543)  
(NASA-CR-154875) Avail NTIS HC A04/MF A01 CSCL 01C

The results of an in-flight simulation program undertaken to study the problems of landing a representative STOL transport in the presence of adverse ground effects are presented Landings were performed with variations in ground effect magnitude ground effect lag, and thrust response Other variations covered the effects of augmented lift response, SAS-failures, turbulence, segmented approach, and flare warning The basic STOL airplane required coordinated use of both stick and throttle for consistently acceptable landings, and the presence of adverse ground effects made the task significantly more difficult Ground effect lag and good engine response gave noticeable improvement, as did augmented lift response Author

**N77-31134\*** National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

**STUDIES OF FRICTION AND WEAR CHARACTERISTICS OF VARIOUS WIRES FOR WIRE-BRUSH SKIDS**

Robert C Dreher Washington Sep 1977 32 p refs  
(NASA-TN-D-8517, L-11625) Avail NTIS HC A03/MF A01 CSCL 01C

The friction and wear characteristics of 22 types and sizes of wires for potential use in wire-brush skids were studied These characteristics were determined by placing brushes made from candidate wires on a belt sander whose moving belt simulated landing roll-out distance At the same time the drag force and wear behavior were monitored Data were obtained over distances up to 3048 m (10,000 ft) at preselected bearing pressures of 172 to 1034 kPa (25 to 150 psi) In general, the friction coefficient developed by the candidate wires was found to be independent of bearing pressure and ranged between 0.4 and 0.6 under the test conditions of this investigation The friction coefficient was not degraded when the surface was wetted and appears to be independent of wire diameter except perhaps when wire size is

relatively large compared with the surface asperities. Generally, the high friction demonstrated by the soft materials was accompanied by high wear rates, conversely the hard materials provided greater wear resistance but offered lower friction. For all test wires, the wear was shown to increase with increasing bearing pressure, in general, for the same bearing pressure, wear increased with increasing wire diameter and decreased when the surface was wetted. Author

**N77-31135\*** National Aeronautics and Space Administration  
Hugh L Dryden Flight Research Center Edwards Calif  
**AN IMPROVED FREE WING FOR AN AIRCRAFT Patent Application**  
Chester H Wolowicz, inventor (to NASA) Filed 8 Sep 1977  
20 p  
(NASA-Case-DFRC-10092-1 US-Patent-Appl-SN-831634)  
Avail NTIS HC A02/MF A01 CSCL 01C

A free wing is attached to a fuselage of an aircraft in a manner such that the wing is free to pivot about a spanwise axis forward of its aerodynamic center. The wing is angularly displaced about the axis by aerodynamic pitching moments, resulting from lift, and is trimmed through a use of a trimmable free stabilizer comprising a floating canard mounted on a strut rigidly connected to the wing and forwardly projected therefrom. NASA

**N77-31136** Army Aviation Engineering Flight Activity, Edwards AFB, Calif  
**AIRWORTHINESS AND FLIGHT CHARACTERISTICS EVALUATION C-12A AIRCRAFT Final Report, 25 Oct 1975 - 14 Feb 1976**  
Joseph C Watts, Vernon L Diekmann, Raymond B Smith, John E Hannon and William A Horton Oct 1976 203 p  
(AD-A040239, USAAEFA-75-08) Avail NTIS  
HC A10/MF A01 CSCL 01/3

The United States Army Aviation Engineering Flight Activity conducted an airworthiness and flight characteristics evaluation of a C-12A aircraft serial number 73-22250, from 25 October 1975 through 14 February 1976. The aircraft was tested at Edwards Air Force Base (field elevation 2302 feet), Paso Robles (field elevation 836 feet), and Lake Tahoe (field elevation 6262 feet) California. During the evaluation 71 flights totaling 6875 productive flight hours were conducted. Performance and handling qualities of the C-12A were evaluated under a variety of operating conditions with emphasis on operation in the normal mission configuration near the maximum gross weight of 12500 pounds. The test aircraft was evaluated against the requirements of Federal Aviation Regulation Part 23, the Beech Aircraft Corporation prime item development specification, and military specification MIL-F-8785B(ASG) to assist in determining operational mission capabilities. Two handling qualities deficiencies were identified. These were the main landing gear wheel lock up tendency which occurred when applying brakes during landing, and the lack of adequate stall warning above 20,000 feet pressure altitude. Twenty shortcomings were noted including four stability and control shortcomings, two lighting system shortcomings, and 14 reliability and maintainability shortcomings. The C-12A failed to meet the single-engine service ceiling, dual-engine cruise ceiling, and the 30,000-foot altitude cruise airspeed guarantees. Two enhancing features were the location of the landing light switches and the rudder boost, which greatly reduced pilot workload during asymmetric power conditions. Author (GRA)

**N77-31137** Naval Air Test Center, Patuxent River, Md  
**FLIGHT CONTROL TESTING OF THE VAK-191B AIRCRAFT**  
Robert L Traskos 24 May 1977 8 p refs  
(AD-A040535, NATC-TM-77-1-SA) Avail NTIS  
HC A02/MF A01 CSCL 01/3

The U.S. Navy/Federal Republic of Germany Joint Flight Test Program, using the VAK-191B aircraft, was conducted to expand the base of VSTOL technology. During the flight program, an integrated test block approach was considered mandatory for the acquisition of the required data in the limited flight time

available. Ground and captive rig tests were used, when applicable, to supplement data acquisition. In spite of the configuration of the captive rig, which precluded its use in the documentation of engine exhaust flow, it was considered a valuable tool in control system and engine test and for pilot familiarization. Author (GRA)

**N77-31138** Army Air Mobility Research and Development Lab, St Louis Mo Systems Research Integrated Office  
**SINGLE-ROTOR HELICOPTER DESIGN AND PERFORMANCE ESTIMATION PROGRAMS VOLUME 1: METHODOLOGY Final Report**  
Milton A Schwartzberg, Roger L Smith, James L Means, Harold Y H Law, and David P Chappell Jun 1977 91 p refs  
(AD-A040803, SRI0-77-1-Vol-1) Avail NTIS  
HC A05/MF A01 CSCL 01/3

Computer programs, designated SSP-1 and SSP-2, have been prepared for (1) the preliminary design of single-rotor helicopters to meet specified mission requirements and (2) the estimation of the performance of single-rotor helicopters of known geometry and with known engine characteristics. The present volume is one of a series describing those computer programs. It details the methodology on which all of those programs are based. Author (GRA)

**N77-31139** Logistics Management Inst Washington D C  
**SENSITIVITY OF ARMY HELICOPTER OPERATING AND SUPPORT COSTS TO CHANGES IN DESIGN AND LOGISTIC PARAMETERS**  
John D Forster May 1977 54 p refs  
(Contract SD-321)  
(AD-A040353, LMI-75-1/4) Avail NTIS HC A04/MF A01  
CSCL 01/3

This study assesses Army helicopter O and S costs and Support Investment (SI) costs in order to assure that the degree of hardware design and logistic parameter sensitivity included in cost estimates accurately reflects actual expenditure sensitivities. Army O and S cost data sources, methodology and approaches are examined and selected cost improvements isolated and evaluated. Strengths of the current costing structure are noted so that they can be carried forward and improved upon to assure accurate representation of new systems to the DSARC. O and S data sources reviewed include reliability, maintainability and field reported cost data. The present methodology and approaches for both Baseline (Program Manager's) Cost Estimates (BCE) and Independent Parametric Cost Estimates (IPCE) are assessed. The dominant O and S costs are found to be Manpower, Replenishment Spares, and Initial Spares. For Manpower and Initial Spares, simplified models are discussed which give OASD visibility into the critical sensitivities of Army helicopter O and S costs. Of the parameters examined for the selected helicopters, O and S costs are most sensitive to the Mean Time Between Dynamic Component Removals (MTBRDC). The report concludes with a discussion of bounding values of Army helicopter O and S cost that can be expected if extreme values of critical O and S cost driving parameters, including those assumed in the cost estimate's approach, are encountered in actual practice. GRA

**N77-31140** Naval Air Development Center Warminster, Pa  
Air Vehicle Technology Dept  
**STATISTICAL REVIEW OF COUNTING ACCELEROMETER DATA FOR NAVY AND MARINE FLEET AIRCRAFT Semiannual Summary Report, 1 Jan 1962 - 31 Dec 1976**  
Alan M Kaniss 1 May 1977 159 p Revised  
(AD-A041266) Avail NTIS HC A08/MF A01 CSCL 01/2

This is a semi-annual progress report, and it presents a specialized summary of the data in the counting accelerometer program. Statistics describing Navy and Marine aircraft cumulative g-count exceedances are calculated and tabulated. These tabulations are separated by calendar time and into four major categories of fleet experience: Navy Training, Navy Combat, Marine Training, and Marine Combat. These data show that the load rate distributions (counts at 1000 hours) for most models and most g-levels have a non-normal distribution. Within a model (F-4B, F-8H, etc.) differences in the average load rates exist when data are separated by calendar time or mission category. Author (GRA)

**N77-31141#** Boeing Aerospace Co., Seattle, Wash Military Airplane Development  
**INNOVATIVE AIRCRAFT DESIGN STUDY (IADS) TASK 2, VOLUME 1 Final Report**  
 E A Barber, D G Blattner, R C Sutton, and M J Mailhot  
 Jun 1977 186 p refs  
 (Contract F33615-76-C-0122)

(AD-A041234) Avail NTIS HC A09/MF A01 CSCL 01/3  
 The study was concerned with the conceptual design and evaluation of military heavy logistics transport aircraft entering service in the 1990-2000 time period. Design payloads of 200,000-600,000 lb and design ranges of 3600-7200 nm were considered. Takeoff field length was 8,000 ft in most cases. Suitability for commercial usage was a major objective. Computer aided design techniques were employed extensively for airplane synthesis and analysis. The study was accomplished in two phases. Phase I included parametric design and analysis of transports in the payload/range categories cited above. An advanced technology review, including evaluations and sensitivity analyses, was accomplished. These studies indicated that substantial gains were possible in reducing operating costs by incorporating both the low risk technology and innovative designs available in 1985, and advanced technology such as composite structures available at a later time. Additional effort is required to identify this increased cost of higher risk advanced technology to determine its cost effectiveness. In Phase II, a baseline mission requiring 3600 nm radius and 400,000 lb payload was selected. GRA

**N77-31142#** Army Aviation Systems Command St Louis Mo Systems Analysis Office  
**CH-47 MEDIUM LIFT HELICOPTER EFFECTIVENESS EVALUATION PROGRAM RUN BOOK Final Report**  
 Mark E Barkley and John A Weaver Jun 1977 37 p refs  
 (AD-A041462, DRS-AV-D-77-10/2 USAVSCOM-TR-77-31)  
 Avail NTIS HC A03/MF A01 CSCL 01/3

This report offers a general description of the Medium Lift Helicopter Effectiveness Evaluation Program instructions for preparing input data and job control language (JCL) card decks, and for consolidating these decks. It also offers definitions of the input/output variables, a listing of the JCL, a sample output listing, and a glossary of the terms used. Author (GRA)

**N77-31143#** Royal Aircraft Establishment, Bedford (England) Aerodynamics Dept  
**COMPARATIVE PERFORMANCE MEASUREMENTS OF TWO HELICOPTER BLADE PROFILES IN HOVERING FLIGHT**

M J Riley and P Brotherhood London Aeron Res Council  
 1977 55 p refs Supersedes RAE-TR-74008, ARC-35289  
 (ARC-R/M-3792, RAE-TR-74008 ARC-35289) Avail NTIS HC A04/MF A01 HMSO £5 PHI

A new blade profile RAE(NPL)9615, was developed for the Lynx helicopter using two-dimensional aerofoil tests. The complex nature of the rotor environment makes it essential to confirm that the designed improvements are realized in flight. The present tests, planned before the Lynx first flew, have simultaneously compared the new profile with the NACA 0012 profile in hovering flight. Each profile took the form of a 'fairing or glove' on a pair of opposing blades of the Wessex helicopter and both local surface pressures and wake pitot pressures were measured. The flight results confirm the comparative reduction in local supersonic velocity and in shock-induced profile drag for the new profile. However differences between flight and tunnel attributable to three-dimensional effects are evident. The results also indicate the complex nature of the flow due to blade vortex interaction and small translation velocities. Author (ESA)

**N77-31144#** Naval Air Test Center, Patuxent River, Md  
**SUMMARY OF HELICOPTER AIRFRAME TESTING IN THE SHIPBOARD ENVIRONMENT**  
 Herman G Kolwey 29 Apr 1977 12 p refs  
 (AD-A039748, NATC-TM-77-2RW) Avail NTIS HC A02/MF A01 CSCL 01/3

This paper presents a summary of test results from several helicopter shipboard test programs. Data are presented from the HH-2D test on the FF-1052 class USS W S SIMS in 1970, the SH-2F on the FF-1052 class USS BOWEN in 1974, and the HH-3F on the WHEC Class USCG HAMILTON in 1975. Improvements in NATOPS manual information are highlighted in the areas of wind and/or airspeed limitations, cockpit indications, and helicopter performance information for both level flight and climb and descent. Shipboard deck strength and landing gear capabilities are addressed and a statistical data base is presented from which extrapolations to the sea state 5 environment may be made. Author (GRA)

**N77-31145#** Naval Postgraduate School, Monterey, Calif  
**A STUDY OF SPECTRUM LOADING AND RANGE-PAIR COUNTING METHOD EFFECTS ON CUMULATIVE FATIGUE DAMAGE M.S. Thesis**

John Scott Atkinson, Jr Mar 1977 118 p refs  
 (AD-A039651) Avail NTIS HC A06/MF A01 CSCL 01/3

This thesis is a study of cumulative fatigue damage. Variations in cumulative fatigue damage resulting from block loading spectra and randomized cycle loading spectra are investigated. Fatigue damage results show the merit of counting load cycles using the range-pair counting method. Complete FORTRAN computer program documentation enables this thesis to serve as a program user's manual. Author (GRA)

**N77-31146#** Rockwell International Corp., Columbus, Ohio  
 Missile Systems Div

**ARPV SYSTEM/DESIGN TRADE STUDY. VOLUME 4: LAUNCH AND RECOVERY**

26 Apr 1976 162 p  
 (Contract F33657-75-C-0518)  
 (AD-A039591, C76-1324/034C-Vol-4) Avail NTIS HC A08/MF A01 CSCL 01/3

On the basis of trade-off analysis of Launch and Recovery Systems for ARPV, the conventional take-off and landing method using high lift wing (STOL) technique, own thrust and arresting gear system emerged as the undisputable leader among the candidate systems. The next system in succession is the STOL configuration using modified SATS catapult conventional gear and arrester gear. The third best system comes out to be a STOL CONFIGURATION - WHEELED DOLLY (STEERABLE) ARRESTER GEAR and INTEGRAL AIR CUSHION. In the fourth place (again in absence of cheap SATS catapults), the Hybrid Truck Launcher with STOL and Arrester Gear SKIDS is the final viable candidate which can be effective as a tactical ARPV system Launch and Recovery Method. GRA

**N77-31147#** Air Force Instrument Flight Center, Randolph AFB, Tex

**ALTITUDE WARNING SIGNAL SYSTEM EVALUATION Final Report**

Kenneth J Kerkering, Gerald C Armstrong, and Dolores M Tyler  
 Apr 1977 23 p  
 (AD-A039365, USAFIFC) Avail NTIS HC A02/MF A01 CSCL 01/4

The Research and Development Division, USAF Instrument Flight Center (USAFIFC/RD) conducted a pilot factors evaluation of the Harrowe Altitude Warning Signal System (AWSS) to determine its acceptability for use in Air Force aircraft. The system has the primary function of assisting pilots in attaining and maintaining assigned or desired (command) altitudes. A secondary function, the approach mode, was incorporated in the AWSS to examine the concept of altitude warning during landing approaches. Thirteen sorties were flown in a NF-38 Talon. Subject pilots were selected from IFC personnel. The overall concept and operation was found to be acceptable by half of the subject pilots. Half of the subject pilots felt the information provided by the system did not justify the increased workload. The normal and approach modes of operation were found to be acceptable in concept, operation, and accuracy. The system in its present configuration is not acceptable for installation in trainer and single place aircraft due to the unacceptable increase in cockpit workload. Author (GRA)

**N77-31148\*** Cincinnati Univ., Ohio Dept of Aerospace Engineering and Applied Mechanics  
**THE EFFECT OF AMBIENT CONDITIONS ON CARBON MONOXIDE EMISSIONS FROM AN IDLING GAS TURBINE COMBUSTOR** M.S. Thesis  
 Anand K Subramaniam 1977 99 p refs  
 (Grant NSG-3045)  
 (NASA-CR-154986) Avail NTIS HC A05/MF A01 CSCL 21E

A test program employing a gas turbine combustor is outlined, the results of which quantize the effects of changes in ambient temperature and humidity on carbon monoxide emissions at simulated idle operating conditions. A comparison of the experimental results with analytical results generated by a kinetic model of the combustion process, and reflecting changing ambient conditions, is given. It is demonstrated that for a complete range of possible ambient variations, significant changes do occur in the amount of carbon monoxide emitted by a gas turbine at idle, and that the analytical model is reasonably successful in predicting changes. Author

**N77-31149\*** General Electric Co., Cincinnati, Ohio Advanced Engineering and Technology Programs Dept  
**NASA/NAVY LIFT/CRUISE FAN. PHASE 1. DESIGN SUMMARY**  
 Sep 1977 276 p refs  
 (Contract NAS3-20048)  
 (NASA-CR-135242 R77AEG180) Avail NTIS HC A11/MF A01 CSCL 21E

The initial design of the LCF459 lift/cruise fan system is documented. The LCF459 is a 15 meter diameter turboprop lift/cruise fan whose design point pressure ratio is 1.32 at a tip speed of 353 meters per second. The gas source for the tip turbine is the YJ97-GE-100 engine. Author

**N77-31150\*** Federal Aviation Administration, Washington, D C  
**NOISE LEVELS FOR TURBOJET POWERED AIRPLANES AND LARGE PROPELLOR DRIVEN AIRPLANES: NOTICE OF PROPOSED RULE MAKING**  
 2 Aug 1976 81 p refs  
 Avail NTIS HC A05/MF A01 CSCL 20A

A proposed amendment to Part 36, Appendix C of the Federal Aviation regulations covering turbojet powered and subsonic large propeller driven airplanes is discussed. Effective perceived noise levels are listed for available and future technology aircraft at sideline, takeoff, and approach. Author

**N77-31153\*** National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio  
**EFFECTS OF TEMPERATURE TRANSIENTS AT FAN INLET OF A TURBOFAN ENGINE**  
 Mahmood Abdelwahab Sep 1977 40 p refs  
 (NASA-TP-1031, E-0162) Avail NTIS HC A03/MF A01 CSCL 21E

The effects of fan inlet temperature transients on the performance and stability of a turbofan engine were determined. The experiment was conducted at 90 and 74 percent of low-pressure-rotor military speed (9525 rpm) and with fan inlet temperature distortions having circumferential extents of 90 deg, 180 deg, 270 deg, and 360 deg. Temperature transients were controlled by varying the magnitude and rate of change of the inlet temperature rise. The engine response ranged from a momentary compressor pressure disturbance to low-pressure-compressor stall. The compressor distortion limits decreased with decreasing low-pressure-rotor speed and increased with increasing circumferential extent of distortion. Analysis of the data suggests strongly that the distortion limits of the compressor are a function of a critical magnitude of inlet temperature rise and are independent of the temperature rise rate. Author

**N77-31154\*** National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio  
**DEVELOPMENT AND VERIFICATION OF REAL-TIME, HYBRID COMPUTER SIMULATION OF F100-PW-100(3) TURBOFAN ENGINE**

John R Szuch, Kurt Seldner, and David S Cwynar Sep 1977 75 p refs  
 (NASA-TP-1034, E-9090) Avail NTIS HC A04/MF A01 CSCL 21E

A real time, hybrid computer simulation of a turbofan engine is described. Controls research programs involving that engine are supported by the simulation. The real time simulation is shown to match the steady state and transient performance of the engine over a wide range of flight conditions and power settings. The simulation equations, FORTRAN listing, and analog patching diagrams are included. Author

**N77-31155\*** National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio  
**ADVANCED TURBOPROP TECHNOLOGY DEVELOPMENT**  
 J F Dugan, D P Bencze, and L J Williams 1977 39 p refs  
 Presented at Aircraft Systems and Technol Meeting, Seattle 22-24 Aug 1977 sponsored by AIAA  
 (NASA-TM-73729, E-9290) Avail NTIS HC A03/MF A01 CSCL 21E

The efficiency of high-speed turboprop propulsion systems is considered with emphasis on fuel savings. Specific topics discussed include (1) high efficiency and low noise of propeller design, (2) fuselage noise attenuation, (3) propeller and gear box maintenance, and (4) engine-airframe integration. J M S

**N77-31156\*** Illinois Univ., Urbana Dept of Aeronautical and Astronautical Engineering  
**PROPELLER STUDY PART 1 INTRODUCTION AND OVERVIEW**  
 Allen I Ormsbee Jul 1977 16 p 3 Vol  
 (Grant NGR-14-005-194)  
 (NASA-CR-155002, AAE-77-12-Pt-1, UIIU-ENG-77-0512-Pt-1) Avail NTIS HC A02/MF A01 CSCL 01C

A general aerodynamic-acoustic theory was developed for determining the acoustical design of propellers used on general aviation aircraft. Data from the theoretical investigation were applied in the design of a propeller whose thrust and torque were measured during a series of YO-3A aircraft flight tests. Author

**N77-31157\*** Illinois Univ., Urbana Dept of Aeronautical and Astronautical Engineering  
**PROPELLER STUDY PART 2: THE DESIGN OF PROPELLERS FOR MINIMUM NOISE**  
 Allen I Ormsbee and Chung-Jin Woan Jul 1977 203 p refs 3 Vol  
 (Grant NGR-14-005-194)  
 (NASA-CR-155005, AAE-77-13-Pt-2, UIIU-ENG-77-0513-Pt-2) Avail NTIS HC A10/MF A01 CSCL 01C

The design of propellers which are efficient and yet produce minimum noise requires accurate determinations of both the flow over the propeller. Topics discussed in relating aerodynamic propeller design and propeller acoustics include the necessary approximations and assumptions involved, the coordinate systems and their transformations, the geometry of the propeller blade, and the problem formulations including the induced velocity, required in the determination of mean lines of blade sections, and the optimization of propeller noise. The numerical formulation for the lifting-line model are given. Some applications and numerical results are included. Author

**N77-31158\*** Illinois Univ., Urbana Dept of Aeronautical and Astronautical Engineering  
**PROPELLER STUDY, PART 3 EXPERIMENTAL DETERMINATION OF THRUST AND TORQUE ON THE YO-3A AIRCRAFT**  
 Allen I Ormsbee, S A Siddiqi, and K R Sivier Sep 1977 60 p refs 3 Vol  
 (Grant NGR-14-005-194)  
 (NASA-CR-155003, AAE-77-14-Pt-3, UIIU-ENG-77-0514) Avail NTIS HC A04/MF A01 CSCL 01C



Instrumentation and procedures for obtaining in-flight measurements of the torque and thrust of a propeller mounted on a YO-3A aircraft are described. Problems encountered in the study are discussed and methods for eliminating these difficulties are suggested. Author

**N77-31161#** Pratt and Whitney Aircraft Group West Palm Beach, Fla. Government Products Div  
**ADVANCED COOLED TURBINE AIRFOIL AERODYNAMIC INVESTIGATION** Final Report, 15 Sep 1975 - 30 Jan 1977

W G Hess Feb 1977 55 p  
 (Contract F33615-76-C-2009)  
 (AD-A041137, AFAPL-TR-76-113) Avail NTIS  
 HC A04/MF A01 CSCL 21/5

Several convectively cooled trailing edge designs were investigated with the objective of eliminating the need for film cooling on the airfoil suction side. A 43.4% reduced solidity first stage turbine vane having potential application for an advanced Air Force fighter engine was selected for the evaluation. The final design eliminates film cooling on the suction side and uses the wavy criss-cross slot as the cooling scheme for the trailing edge section. The cooling design was incorporated into a cascade test airfoil using the radial wafer fabrication technique. The airfoil was constructed by photoetching the cooling design into the individual wafers, bonding the wafers together and machining the bonded block into the airfoil shape. The airfoil was subsequently evaluated in an airfoil cascade test to determine the aerodynamic and cooling performance. The aerodynamic profile loss of the reduced solidity radial wafer airfoil was reduced 56% relative to a baseline 43.4% reduced solidity configuration with film cooled suction surface and was 30% under the program goal. The wavy criss-cross slot design used in the trailing edge section proved to be an efficient cooling technique, and eliminated the need for suction side film cooling. GRA

**N77-31162#** Thermal Technology Labs, Buffalo, N Y  
**DEVELOPMENT OF LIGHTWEIGHT TRANSFORMERS FOR AIRBORNE HIGH POWER SUPPLIES** Interim Report, Jan. 1975 - Jun 1976

D L Lockwood, R I McNall, Jr and R L Haumesser Dec 1976 90 p refs  
 (Contract F33615-75-C-2014 AF Proj 3145)  
 (AD-A041515, AFAPL-TR-76-102) Avail NTIS  
 HC A05/MF A01 CSCL 09/1

Several major developments have occurred in this program. As is often the case in research they did not occur exactly in accordance with the original plan. The total program however is essentially on schedule. New techniques for fabrication of pie wound transformers were developed which yielded superior designs. This development was followed by the development of computer aided design programs for pie wound transformers. Several 10KW transformers have been fabricated and subjected to a variety of tests. Based on the results of these tests both the 10KW and 200 KW transformers will be pie rather than layer wound. A 10KW transformer rectifier system is presently being integrated with a breadboard inverter for final verification. During the first half of this program, a numerical method was developed for the solution of the nonlinear lumped parameter transformer model. This model was developed under the previous contract, but no stable solution had been found. The present solution is for a resistive load and work is continuing to include leakage inductance, shunt capacitance, and an arbitrary load impedance. The present program has been implemented on the HP 9830 machine. As mentioned above, pie wound transformer design programs have been written. These are for interactive design on the HP 9830 and are not self optimizing routines. A decision should be made as to the ultimate application of these programs before a decision whether or not to implement them on the CDC 6600 is reached. GRA

**N77-31163#** Rolls-Royce Ltd., Derby (England)  
**FAN SUPERSONIC FLUTTER PREDICTION AND TEST ANALYSIS**

D G Halliwell London Aeron Res Council 1977 24 p  
 refs Supersedes ARC-36374  
 (ARC-R/M-3789, ARC-36374) Avail NTIS HC A02/MF A01,  
 HMSO £3 PHI

The aerodynamic and vibration characteristics of unstalled supersonic flutter in fan assemblies having part-span shrouds or clappers are described. It is briefly compared and contrasted with stall flutter. The importance of frequency and modeshape analyses is stressed and supersonic flutter prediction methods are examined, commencing with the modeshape parameter. Unsteady work theory leads to the study of aerodynamic damping with the prediction of flutter mode speed and wave direction. Throughout, emphasis is given to the support of design analysis by test data, from laboratory measurements on stationary models to full scale engine altitude test chamber behavior. Finally, the effect on flutter of some of the opening criteria in engine service is considered. Author (ESA)

**N77-31168#** California Research and Technology, Inc., Woodland Hills

**NUMERICAL ANALYSES OF SOFT BODY IMPACTS ON RIGID AND DEFORMABLE TARGETS** Interim Technical Report, Jul - Dec 1975

M Rosenblatt, G E Eggum, L A DeAngelo, and K N Kreyenhagen Dec 1976 96 p refs  
 (Contract F33615-75-C-5052)  
 (AD-A040030 AFML-TR-76-202) Avail NTIS  
 HC A05/MF A01 CSCL 21/5

A two-dimensional finite difference code, WAVE-L, was used to investigate the impact of soft bodies (birds) on both rigid and deformable targets. The soft body was numerically modeled as a water sphere. Three impact cases were examined: impacts onto rigid targets (both normal and oblique), impact onto a deformable target (a stainless steel disk) and impact onto the edge of a typical jet engine fan blade. For the impacts onto rigid targets the finite difference calculation was used to obtain the pressures produced at impact, the distribution of pressure over the target and the total force exerted on the target. These calculations were compared with experimentally measured values. The impact onto a stainless steel disk was also modeled with the finite difference code. Plate deformation, impact pressures and forces were calculated. The fan blade impacts were modeled in two phases. The impact loading pressures and forces were calculated with the finite difference model. The blade was then modeled with a three dimensional finite element code, NON-SAP, using the finite difference pressures on impact. Author (GRA)

**N77-31169#** Princeton Univ., N J Dept of Aerospace and Mechanical Science

**RESEARCH ON NOISE GENERATED BY DUCTED AIR-FUEL COMBUSTION SYSTEMS** Final Report, Mar 1971 - Mar 1977

E G Plett and M Summerfield Mar 1977 32 p refs  
 (Contracts N00014-67-A-0151-0029 N00014-75-C-0507)  
 (AD-A039957, AMS-1327) Avail NTIS HC A03/MF A01  
 CSCL 21/5

Throughout the research program, emphasis has been placed on obtaining a better understanding of the importance of combustion as a source of noise in jet engines. This has been pursued in terms of theoretical modeling and experimental investigations. A theoretical model was developed to allow computation of the role internal sources as well as external sources. Calculations based on reasonable approximations indicated that for subsonic jet velocities, internal sources could be much more important than the jet noise sources. Experiments in a cold flow with cylindrical struts immersed in the flow to generate unsteadiness demonstrated this effect. More to the point, experiments with a ducted combustor also verified that the combustion though occurring inside the duct, causes unsteadiness in the exhaust flow which is directly responsible for noise generation. The noise thus attributable to the combustion was found to be dominant over jet noise for subsonic jets to Mach numbers of approximately 0.6. A unified theory of combustion noise generation was developed. Direct verification of the importance of the various source terms was begun. Initial results suggest that at least several of the terms are important. GRA

**N77-31170#** Bolt Beranek and Newman Inc., Canoga Park Calif

**CALCULATION OF SIDE LINE NOISE LEVELS DURING TAKEOFF Technical Report, Aug. - Sep 1976**

John F Mills Sep 1976 30 p refs

(Contract F33615-76-C-0507)

(AD-A040624 BBN-3298 AMRL-TR-76-123) Avail NTIS HC A03/MF A01 CSCL 01/5

This report discusses an improved analytical approach for computing the sideline noise generated by aircraft during takeoff roll. The relationship accounts for the effects of acceleration on the typical shape of noise radiation pattern from a static full-power ground runup. This simplified model is suitable for hand calculations or direct implementation into NOISEMAP, the computerized procedure used by the Air Force to generate contours of equal noise exposure about airbases resulting from aircraft flight and ground runup operations. For the Boeing 707-300 aircraft, the new simplified model yielded results within 0.5 db of those obtained with more complex computational procedures involving the effects of forward speed on the jet noise output. GRA

**N77-31171#** Exxon Research and Engineering Co., Linden, N.J. Government Research Lab

**DEVELOPMENT OF A CATALYTIC COMBUSTOR FOR AIRCRAFT GAS TURBINE ENGINES Final Technical Report, 22 May 1976 - 22 Sep 1976**

Vincent J Siminski and Henry Shaw 22 Sep 1976 166 p refs

(Contract F33615-75-C-2033)

(AD-A040135, EXXON/GRU 1BFA 76 AFAPL-TR-76-80) Avail NTIS HC A08/MF A01 CSCL 21/5

The pollution problems associated with unburned hydrocarbons and carbon monoxide in the idle mode, and NOx and smoke production in the power mode of aircraft gas turbine operation can be minimized using hybrid catalytic combustion. A hybrid catalytic combustor consists of a fuel-rich precombustor, secondary air quenching zone, and monolithic catalyst stage which rapidly oxidizes CO and UHC produced in the pre-combustor. The concentration of thermally-produced NOx in the pre-combustor is very low because of the lack of oxygen. However, the formation of NOx precursors such as HCN and NH3 produced under fuel rich conditions must be considered. Data showed that nitrogenous species produced in the rich pre-combustion zone were efficiently converted to NOx by catalysts under the very lean mixture conditions that result from the secondary air quench. The equivalence ratio in the pre-combustor was varied from 0.5 to 1.5, while the overall mixture, after secondary air injection, was in the range of 0.1 to 0.3. GRA

**N77-31172#** General Electric Co., Cincinnati, Ohio Aircraft Engine Group

**DIGITAL SHAFT ENCODER Final Technical Report, Feb. 1974 - Oct. 1976**

William R Spencer and Howard B Kast Dec 1976 65 p

(Contract F33615-74-C-2007)

(AD-A040706, R77AEG194, AFAPL-TR-76-106) Avail NTIS HC A04/MF A01 CSCL 21/5

This report documents the design, test, and development of a high temperature digital rotary position transducer. Use of magnetic sensors in this shaft encoder eliminates the need for brushes or light sources to create the eight-bit digital output signal. Included in the project were environmental testing and on-engine operation. A digital electronic readout instrument was built to aid circuit development and testing. The simple construction of the encoder makes this device well suited for aircraft engine applications. Author (GRA)

**N77-31173#** Iowa State Univ. of Science and Technology Ames Engineering Research Inst

**MULTISTAGE AXIAL-FLOW TURBOMACHINERY WAKE PRODUCTION, TRANSPORT, AND INTERACTION Interim Report, 1 Sep 1975 - 30 Sep 1976**

Douglas P Schmidt and Theodore H Okishi Nov 1976 237 p refs

(Contract AF-AFOSR-2916-76)

(AD-A041108 ISU-ERI-AMES-77130, TCRL-7

AFOSR-77-0720TR) Avail NTIS HC A11/MF A01 CSCL 13/7

The first year results of a study of multistage axial-flow turbomachine wake production transport and interaction are described in this report. Evidence indicating how the noise level measured at the inlet of a low speed, multistage, axial-flow research compressor was found to vary appreciably with inlet guide vane and stator row relative circumferential positioning with the largest amount of noise reduction occurring at the blade passing frequency. The results of detailed slow- (cobra probe and surface pressure taps) and fast-response (hot-wire) measurements made within the research compressor flow field to aid in understanding the physics involved are shown in scalar and vector plots and tables. Significant local changes in blade-section aerodynamic performance and flow field appearance with variation in stationary blade row placement were observed although corresponding improvement of overall efficiency could not be ascertained. Several interesting periodically unsteady aspects of the flow field and its measurement are demonstrated and some conclusions about blade row interaction are proposed. Author (GRA)

**N77-31174\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

**A FAILURE EFFECTS SIMULATION OF A LOW AUTHORITY FLIGHT CONTROL AUGMENTATION SYSTEM ON A UH-1H HELICOPTER**

Lloyd D Corliss and Peter D Talbot Aug 1977 46 p refs

Prepared in cooperation with USAAMRDL, Moffett Field, Calif (NASA-TM-73258, A-7097) Avail NTIS HC A03/MF A01 CSCL 01C

A two-pilot moving base simulator experiment was conducted to assess the effects of servo failures of a flight control system on the transient dynamics of a Bell UH-1H helicopter. The flight control hardware considered was part of the V/STOLAND system built with control authorities of from 20-40%. Servo hardover and oscillatory failures were simulated in each control axis. Measurements were made to determine the adequacy of the failure monitoring system time delay and the servo center and lock time constant, the pilot reaction times, and the altitude and attitude excursions of the helicopter at hover and 60 knots. Safe recoveries were made from all failures under VFR conditions. Pilot reaction times were from 0.5 to 0.75 sec. Reduction of monitor delay times below these values resulted in significantly reduced excursion envelopes. A subsequent flight test was conducted on a UH-1H helicopter with the V/STOLAND system installed. Series servo hardovers were introduced in hover and at 60 knots straight and level. Data from these tests are included for comparison. Author

**N77-31175\*#** National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

**A MATHEMATICAL FORCE AND MOMENT MODEL OF A UH-1H HELICOPTER FOR FLIGHT DYNAMICS SIMULATIONS**

Peter D Talbot and Lloyd D Corliss Jun 1977 45 p refs

Prepared in cooperation with USAAMRDL, Moffett Field, Calif (NASA-TM-73254, A-7080) Avail NTIS HC A03/MF A01 CSCL 01C

A model of a UH-1H helicopter was developed to support flight simulations and for developmental work on an avionics system known as V/STOLAND system. Equations and numerical values of constants used to represent the helicopter are presented. Responses to step inputs of the cyclic and collective controls are shown and compared with flight test data for a UH-1H. The model coefficients were adjusted in an attempt to get a consistent match with the flight time histories at hover and 60 knots. Response matching was obtained at 60 knots, but the matching at hover was not as successful. Pilot evaluations of the model, both fixed and moving base, were made. Author

promise to be superior to any contemporary airplanes in terms of cost-effectiveness and energy-hydrocarbon jet fuel, whether manufactured from oil shale, coal or crude oil, remains the most attractive aviation fuel for future Air Force use. Policy recommendations are made pertaining both to alternative fuels and to advanced-technology large airplanes. Future research and developments are also identified. Author (GRA)

**N77-31355\*** National Aeronautics and Space Administration  
Lewis Research Center, Cleveland, Ohio

**ASDAR (AIRCRAFT TO SATELLITE DATA RELAY) FLIGHT TEST REPORT**

Edward J Domino, Robert R Lovell Martin J Conroy and David H Culp Aug 1977 21 p  
(NASA-TM-73744 E-9311) Avail NTIS HC A02/MF A01 CSCL 17B

The aircraft to Satellite Data Relay (ASDAR) an airborne data collection system that gathers meteorological data from existing aircraft instrumentation and relays it to ground user via a geo-synchronous meteorological satellite, is described and the results of the first test flight on a commercial Boeing 747 aircraft are presented. The flight test was successful and verified system performance in the anticipated environment. Author

**N77-31368\*** Naval Ocean Systems Center San Diego Calif  
**AN/PRC-56 HELMET RADIO SET UPGRADING RECOMMENDED MODIFICATIONS REQUIRE MINIMAL RESOURCES BUT PROMISE CONSIDERABLE IMPROVEMENT IN RELIABILITY OPERABILITY, AND LOGISTICS SUPPORT**  
Technical Document, Jul 1976 - Apr 1977

T H Townsend 15 May 1977 29 p refs  
(AD-A041190, NOSC/TD-105) Avail NTIS HC A03/MF A01 CSCL 17/2

A field change, printed as an appendix to this document, is recommended as the means of accomplishment for most of the corrective actions suggested here. It includes new on/off and push-to-talk switches a microphone with windscreen a longer microphone boom an improved squelch adjustment, improved-reliability parts, more-stable tuning and sidetone. Action by depot and navelx is also recommended. Author (GRA)

**N77-31384\*** Mississippi State Univ Mississippi State Engineering Industrial Research Station

**A STUDY OF THE CHARGE AND CURRENT INDUCED ON AN AIRCRAFT IN AN EMP SIMULATOR FACILITY PART 1 THE FORMULATION PART 2 THE SINGULARITY EXPANSION METHOD PART 3 THE NUMERICAL RESULTS** Final Report

Clayborne D Taylor Keh-Tong Chen Terry T Crow and Murali Kumbale Dec 1976 168 p refs  
(Grant AF-AFOSR-2961-76)  
(AD-A039507 AFOSR-77-0636TR) Avail NTIS HC A08/MF A01 CSCL 18/3

A study of the aircraft skin current and charge is made for an aircraft under the illumination of the electromagnetic field produced by a nuclear EMP simulator. This work is motivated by the need to relate the response of an aircraft in the EMP simulator to the response of an aircraft under actual EMP illumination. The analysis toward a specific EMP simulator at Kirtland AFB New Mexico however, the methodology presented is applicable to other types of simulator facilities. Author (GRA)

**N77-31389\*** TDR, Inc., Los Angeles, Calif  
**FOUNDATION OF THE MAGNETIC FIELD INTEGRAL EQUATION CODE FOR THE CALCULATION OF THE ELECTROMAGNETIC PULSE EXTERNAL INTERACTION WITH AIRCRAFT** Final Report

Maunce I Sancer, Scott Siegel and A D Varvatsis Apr 1977 147 p refs  
(Contract F29601-75-C-0067)  
(AD-A039953, AFWL-TR-76-279) Avail NTIS HC A07/MF A01 CSCL 01/3

This report presents the equations that are programmed along with their derivations and the underlying theory. The code

determines the current density and charge density induced on a model of an aircraft. The equations that are programmed result from patch zoning the aircraft model in order to obtain a solution to the frequency domain representation of the magnetic field integral equation. The intent is to obtain solutions for a continuous spectrum that includes the low and resonant range of frequencies corresponding to the bulk of the energy in a typical EMP spectrum. Author (GRA)

**N77-31440\*** National Aeronautics and Space Administration  
Langley Research Center, Langley Station, Va  
**HEAT-TRANSFER AND PRESSURE MEASUREMENTS ON A SIMULATED ELEVEN DEFLECTED 30 DEG NEAR FLIGHT CONDITIONS AT MACH 7**

Charles B Johnson, Allan H Taylor, (Vought Corp., Hampton, Va), and Irving Weinstein Sep 1977 36 p refs  
(NASA-TM-X-3563, L-11524) Avail NTIS HC A03/MF A01 CSCL 20D

Heat transfer rates and pressures were obtained on an eleven plate (deflected 30 deg) and a flat plate upstream of the eleven in an 8 foot high-temperature structures tunnel. The flight Reynolds number and flight total enthalpy for altitudes of 26.8 km and 28.7 km at Mach seven were duplicated. The heat transfer and pressure data were used to establish heating and pressure loads. The measured heating was compared with several theoretical predictions, and the closest agreement obtained with a Schultz-Grunow reference enthalpy method of calculation. Author

**N77-31477\*** ARO, Inc., Arnold Air Force Station Tenn  
**LASER VELOCIMETER UTILIZATION IN JET ENGINE ALTITUDE TEST CELLS** Final Report, Oct 1976 - Jun. 1976

D O Barnett AEDC Jun 1977 36 p refs  
(AD-A041019, ARO-ETF-TR-76-147, AEDC-TR-77-21) Avail NTIS HC A03/MF A01 CSCL 14/2

The feasibility of utilizing a laser velocimeter (LV) in turbine engine testing in an altitude test cell was investigated. A one-component LV and associated environmental control system (ECS) were designed, fabricated and installed in Test Cell J-2 of the Engine Test Facility (ETF). LV measurements made on the centerline of an F101 engine at one axial station downstream of the nozzle exit are presented and compared to the calculated exit velocity. Design data are presented on the vibration levels and temperatures encountered by the LV over a range of engine operating conditions. It was found that sufficient natural seed material existed in the exhaust flow to allow the LV to characterize the exit velocity of a turbojet engine during altitude testing. Author (GRA)

**N77-31507\*** Timken Co Canton Ohio  
**TAPERED ROLLER BEARING DEVELOPMENT FOR AIRCRAFT TURBINE ENGINES** Final Report, 8 Mar. 1976 - 8 Mar 1977

Peter S Orvos Wright-Patterson AFB Ohio AFAPL Apr 1977 92 p refs  
(Contract F33615-76-C-2019)  
(AD-A041317 AFAPL-TR-77-6) Avail NTIS HC A05/MF A01 CSCL 21/5

Finite element methods were used to structurally analyze various potential high speed tapered roller bearing cage designs. These cage designs included roller guided and race guided configurations. The two approaches used in the analysis were first to model the full cage using beam elements and then intensively analyze a segment using solid elements. In summary it was determined that centrifugal forces mostly affect high speed cage stress and deformation, and the race guided cage exhibits the greatest strength. Author (GRA)

**N77-31516\*** Johns Hopkins Univ., Baltimore Md Dept of Mechanics and Materials Science  
**ULTRASONIC DETECTION OF FATIGUE DAMAGE IN AIRCRAFT COMPONENTS** Annual Report, 1 Mar - 28 Feb 1977

Robert E Green, Jr and Robert B Pond, Sr Mar 1977  
114 p refs  
(Contract F44620-76-C-0081)  
(AD-A040009, AFOSR-77-0658TR) Avail NTIS  
HC A06/MF A01 CSCL 11/6

The purpose of the present research is to extend and apply the ultrasonic techniques developed under AFOSR Contract No F44620-71-C-0062 to the detection of fatigue damage in test specimens which are made from materials and possess geometries typical of actual aircraft components. Ultrasonic attenuation measurements made simultaneously with fatigue tests on aluminum alloy bars gave warning of crack formation and eminent fracture much earlier than conventional ultrasonic methods. Similar tests are currently being run on aluminum alloys possessing geometries typical of actual aircraft components. Analysis of acoustic emission measurements made simultaneously with ultrasonic attenuation measurements during fatigue testing have run into difficulty because of the lack of a proper acoustic emission characterization system which would permit optimum separation of the defect created acoustic emission signals from the background noise. GRA

**N77-31529#** TRW Defense and Space Systems Group, Redondo Beach, Calif

**ADVANCED HIGH SPEED ROLLER BEARING INSPECTION TECHNIQUES** Final Report, 30 Oct 1976 - 1 Apr. 1977  
Jerold L Jacoby and Jack R Bohn May 1977 80 p refs

(Contract F33615-76-C-2147)  
(AD-A042121, AFAPL-TR-77-32) Avail NTIS  
HC A05/MF A01 CSCL 14/2

A comprehensive survey of state-of-the-art precision measurement techniques applicable to dimensional inspection of rollers for high speed bearings (greater than 20 million DN) was undertaken. Particular attention was given to noncontacting techniques which would permit automated 100% inspection of the rollers for use in such bearings. The measurement techniques were evaluated to determine their utility for incorporation into a cost-effective roller inspection system. A concept for a fully automated roller inspection system is described. It provides for the preparation, inspection, re-oiling and sorting of the rollers with minimal human supervision. The system is conceived to be self-contained so that it can operate independent of environmental constraints. It can be developed by adapting existing technology to the specific requirements for roller inspection. Author (GRA)

**N77-31537#** Old Dominion Univ Research Foundation, Norfolk Va

**VIBRATION ANALYSIS OF ROTOR BLADES WITH AN ATTACHED CONCENTRATED MASS** Technical Report, 1 Jun - 15 Aug 1976

V R Murthy and P S Barna Aug 1977 191 p refs  
(Grant Nsg-1143)  
(NASA-CR-154987) Avail NTIS HC A09/MF A01 CSCL 20K

The effect of an attached concentrated mass on the dynamics of helicopter rotor blades is determined. The point transmission matrix method was used to define through three completely automated computer programs the natural vibrational characteristics (natural frequencies and mode shapes) of rotor blades. The problems of coupled flapwise bending chordwise bending, and torsional vibration of a twisted nonuniform blade and its special subcase pure torsional vibration are discussed. The orthogonality relations that exist between the natural modes of rotor blades with an attached concentrated mass are derived. The effect of pitch rotation, and point mass parameters on the collective, cyclic, scissor, and pure torsional modes of a seesaw rotor blade is determined. Author

**N77-31722#** Air Force Geophysics Lab, Hanscom AFB, Mass  
**A METHOD FOR DETERMINING THE POINT OF LIFT-OFF AND MODIFIED TRAJECTORY OF A GROUND-BASED HEATED TURBULENT PLANAR JET IN A CO-FLOWING WIND**

Milton M Klein 2 Feb 1977 23 p refs  
(AD-A040704, AFGL-TR-77-0033, AFGL-AFSG-361) Avail  
NTIS HC A02/MF A01 CSCL 04/1

Experimental and theoretical programs are being conducted to aid in the development of an operational Warm Fog Dispersal System using ground based heat sources. To help determine optimum heat and thrust combinations for the system, investigations have been made of the buoyant motion of heated turbulent jets in co-flowing, that is, same direction ambient winds. To take account of the ground effect an analysis has been made of the experimental data for the planar jet at the point of lift-off in terms of the local Froude number at this point. From this correlation a procedure has been developed for determining the lift-off point, using the ambient wind and initial velocity and temperature of the jet as input variables. A new jet trajectory may now be easily calculated with only a simple modification of the original method in which the ground effect was ignored. GRA

**N77-31922#** Bolt, Beranek, and Newman, Inc., Canoga Park, Calif

**SELECTION OF MINIMUM DAY/NIGHT LEVELS FOR NOISEMAP CONTOUR CALCULATIONS**

Dwight E Bishop Nov 1976 15 p  
(Contract F33615-76-C-0507 AF Proj 7231)  
(AD-A040623, BBN-10189, AMRL-TR-76-124) Avail NTIS  
HC A02/MF A01 CSCL 01/5

This report discusses guidelines for the minimum Day/Night Level (DNL) values that should be used with NOISEMAP type computations to (1) insure adequate accuracy of the lowest contour level for a given set of aircraft operations, and (2) minimize the number of machine computations and thereby reduce operating costs. An analysis is made of the errors introduced in the DNL contour values due to truncation of the partial DNL cutoff determined by the single event noise level or the number of aircraft operations for a particular flight path. For a given airbase and fixed volume of aircraft operations, the cutoff occurs at higher single event noise levels as the number of aircraft flight paths or aircraft classes are increased. Finer detail in describing the aircraft operations results in the cutoff noise levels being raised with an increased error at the edges of the DNL grid computations, but with a corresponding decrease in the machine running time. These DNL cutoff guidelines have been incorporated into version 3.4 of NOISEMAP. Author (GRA)

**N77-32012#** Northrop Corp., Hawthorne, Calif Aircraft Div  
**WAVE DRAG REDUCTION FOR AIRCRAFT FUSELAGE-WING CONFIGURATIONS VOLUME 1 ANALYSES AND RESULTS** Final Report, 30 Jun 1975 - 30 Oct 1976

C W Chu, J Der, Jr, and H Ziegler Warminster Pa NADC  
Oct 1976 143 p refs  
(Contract N62269-75-C-0537)  
(AD-A040997, NOR-76-190-Vol-1 NADC-77157-30-Vol-1)  
Avail NTIS HC A07/MF A01 CSCL 05/2

An optimization procedure has been developed to minimize the wave drag of an aircraft fuselage-wing configuration subject to constraints imposed by design requirements. The theory, methods, computer programs and results are presented in this report in two volumes. This volume describes analyses, results and the optimization procedure. The procedure makes use of the Latin Square sampling technique and the Three-Dimensional Method of Characteristics. The former is used to efficiently sample the family of configurations, and the latter is used to accurately calculate the wave drags of the sampled configurations. The calculated wave drag coefficients are then used to derive a functional dependence of the wave drag on the geometric variables that define the family of configurations. The minimum wave drag configuration can be obtained by minimizing the wave drag function subject to a given set of constraints. The wave drag reduction procedure is demonstrated using an F-4 type configuration as the baseline. The results are presented and discussed. GRA

**N77-31176#** National Aeronautics and Space Administration Langley Research Center Langley Station Va  
**VORTEX-LIFT ROLL-CONTROL DEVICE Patent Application**  
 John E Lamar, inventor (to NASA) Filed 21 Mar 1977 11 p  
 (NASA-Case-LAR-11868-2, US-Patent-Appl-SN-779429) Avail  
 NTIS HC A01/MF A02 CSCL 01C

A wing is described which constitutes a roll control device for aircraft of cropped, arrow-type planform with thin leading and side edges having a pivotable tip to alter the crop angle of the wing during flight Increasing the crop angle causes the wing side edge to become a trailing edge thereby reducing the wing surface area which the leading edge and side edge shed vortex systems can act against This reduction also diminishes the strength of the shed vortex system Decreasing the crop angle causes opposite results  
 NASA

**N77-31177#** Technische Hochschule Darmstadt (West Germany) Inst fuer Flugtechnik  
**INVESTIGATION OF FLIGHT DYNAMICS DURING ROLL [UNTERSUCHUNG DER FLUGDYNAMIK BEIM ROLLEN]**  
 H D Finck and G Sachs 5 Apr 1976 58 p refs In GERMAN

(IFD-8/76) Avail NTIS HC A04/MF A01

The dynamics of a highly maneuverable subsonic aircraft during multiple roll around the length axis were investigated with a 6 deg of freedom computer program The nonlinear dependencies on the aerodynamic forces and moments are taken into account The effect of the dynamic derivation of lateral motion on the overall motion is shown The relationship between the position of the overall rotation vector and the velocity vector is represented  
 ESA

**N77-31178#** Technische Hochschule, Darmstadt (West Germany) Inst fuer Flugtechnik

**RECOGNITION CRITERION AND PRODUCTION OF EASILY SOLVABLE MODELS FOR FLIGHT MECHANICAL OPTIMIZATION PROBLEMS [ERKENNUNGSKRITERIUM UND ERZEUGUNG LEICHT LOESBARER MODELLE FUER FLUGMECHANISCHE OPTIMIERUNGSPROBLEME]**  
 Bernd Faber 12 Nov 1976 118 p refs In GERMAN

(IFD-9/76) Avail NTIS HC A06/MF A01

A simplification scheme is presented for obtaining easily solvable flight mechanical optimization models based on point-wise optimization, which allows attaining the least number of physical approximations Several extensively described examples show that new optimization statements can be obtained easily by using the scheme The point-wise method is applicable in combination with a solution scheme  
 ESA

**N77-31179#** National Aerospace Lab, Amsterdam (Netherlands) Flight Dynamics Div

**HANDLING QUALITY CRITERIA DEVELOPMENT FOR TRANSPORT AIRCRAFT WITH FLY-BY-WIRE PRIMARY CONTROL SYSTEMS**

H A Mooij 9 May 1977 124 p refs  
 (Contracts NIVR-1745, RB-RD-1973-1 1)

(NLR-TR-74141-U) Avail NTIS HC A06/MF A01

The introduction of fly-by-wire primary flight control systems in certain categories of future transport aircraft, makes it highly desirable to initiate further studies into handling quality criteria for future guidance in system design and airworthiness certification The handling quality criteria for such aircraft must be based on parameters which describe the combination of the aircraft and its closed-loop flight control system Approach flight simulation and compensatory tracking, performed on a moving base flight simulator as applied to a conceptual jet transport developed around the relaxed static stability concept, is described The frequency of the dominant mode of the pitch attitude control system and the effectiveness of the direct-lift-control-system were the parameters varied Results of the flight simulator experiment and a pilot-aircraft system analysis are discussed In the literature proposed criteria (two-aircraft state variable weighted sum and the pilot-in-the-loop criteria) are evaluated against simulator results obtained in this program  
 Author (ESA)

**N77-31180#** National Aerospace Lab, Amsterdam (Netherlands) Flight Dynamics Div

**THE NEED OF STICK FORCE STABILITY FOR ATTITUDE-STABILIZED AIRCRAFT, PART 1**

H A Mooij and M F C van Gool 19 Mar 1976 62 p refs  
 (Contracts NIVR-1745 RB-RD-1975-1 1)

(NLR-TR-76125-U) Avail NTIS HC A04/MF A01

After introductory background information on the landing approach piloting task and some arguments for expanding the knowledge of handling quality criteria for certain advanced transport designs, results are given of the flight tests related to the effect of positive stick force stability on the longitudinal controllability in the landing approach of an attitude-stabilized aircraft Positive stick force stability reduced airspeed deviations from the reference speed and the subjective pilot effort spent on airspeed holding for the aircraft configuration investigated Based on the results obtained, follow-up testing, using a jet transport aircraft during visual approaches, is recommended  
 Author (ESA)

**N77-31184#** Naval Air Propulsion Test Center Trenton NJ Dept of Propulsion Technology and Project Engineering

**NAPTC FACILITY MODIFICATIONS REQUIRED FOR ALTITUDE TESTING OF CURRENT V/STOL ENGINE Final Report**

Joseph F Boytos and John Lezniak May 1977 42 p refs

(AD-A041608, NAPTC-PE-102) Avail NTIS  
 HC A03/MF A01 CSCL 21/5

Modifications were made to NAPTC altitude chamber 3E to provide the capability to test current V/STOL aircraft engines A test program was conducted with a F402 vectored-thrust turbofan engine to evaluate the modifications and verify facility operational capability  
 Author (GRA)

**N77-31218#** Kaman Sciences Corp Colorado Springs Colo  
**AN EVALUATION OF BOUNDARY LAYER FORCES AND MEASUREMENT METHODS Final Report**

J C Nickell, V D Peckham, and T F V Meagher Oct 1976 146 p refs

(Contract DNA001-75-C-0038)

(AD-A040947, K-76-118U(R), DNA-4202F) Avail NTIS  
 HC A07/MF A01 CSCL 20/4

An analysis has been performed of the effects of asymmetric hypersonic boundary layer transition on conical reentry vehicles relative to the forces and moments acting on the vehicle The relative importance of boundary layer thickening increased surface mass transfer, and changes in skin friction have been addressed and the effects of each of these terms on the vehicle forces and moments have been estimated This analysis indicates that boundary layer thickening is the most significant factor occurring during boundary layer transition and may be a source of transient vehicle instability during the boundary layer transition event  
 GRA

**N77-31334#** RAND Corp Santa Monica, Calif

**AN EVALUATION OF VERY LARGE AIRPLANES AND ALTERNATIVE FUELS Interim Report**

W T Mikolowsky L W Noggle, W F Hederman and R E Horvath Dec 1976 401 p refs

(Contract F49620-77-C-0023)

(AD-A040532, R-1889-AF) Avail NTIS HC A18/MF A01  
 CSCL 01/3

Very large airplanes using alternative fuels are examined in the context of existing and possible future Air Force missions Synthetic jet fuel (JP), liquid methane liquid hydrogen, and nuclear propulsion are the fuel alternatives selected for detailed analysis Conceptual designs of airplanes using each of these fuels were developed and estimates were made of their life-cycle cost and life-cycle energy consumption Mission analyses were performed to determine the effectiveness of the alternative airplanes in strategic airlift specifically and in the station-keeping role in general Results indicate that for most military applications airplanes with gross weights in excess of one million pounds

**N77-32013#** Northrop Corp Hawthorne, Calif  
**WAVE DRAG REDUCTION FOR AIRCRAFT FUSELAGE-  
WING CONFIGURATIONS. VOLUME 2 MANUAL FOR  
COMPUTER PROGRAMS** Final Report, 30 Jun 1975 -  
30 Oct 1976

C W Chu, J Der Jr and H Ziegler Oct 1976 379 p  
(Contract N62269-75-C-0537)  
(AD-A040998, NOR-76-190-Vol-2, NADC-77157-30-Vol-2)  
Avail NTIS HC A17/MF A01 CSCL 05/2

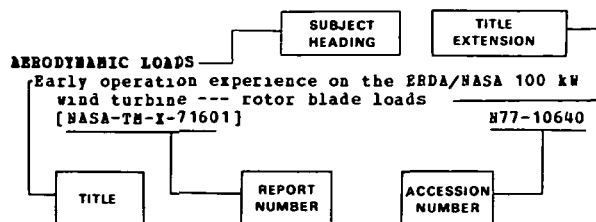
An optimization procedure has been developed to minimize the wave drag of an aircraft fuselage-wing configuration subject to constraints imposed by design requirements. The theory, methods, computer programs and results are presented in this report in two volumes. This volume is the user's manual for the computer programs. The input/output information is described in detail. Listings of the programs are given and samples of built-in program diagnostic messages are explained. Also included are the logical structures of the programs and the descriptions of the subroutines which in combination with the program listings can be used for possible future modification, improvement, or extension of these computer programs. GRA

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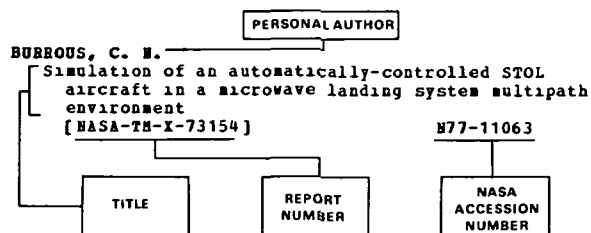
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